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REPORTS AND PAPERS

ON

BOTANY.

CONSISTING OF

Hugo von

I.—MOHL ON THE STRUCTURE OF THE PALM-STEM.

Karl

II.—NÄGELI ON VEGETABLE CELLS.

III.—NÄGELI ON THE UTRICULAR STRUCTURES IN THE CONTENTS OF CELLS.

Heinrich Friedrich

IV.—LINK'S REPORT ON PHYSIOLOGICAL BOTANY FOR 1844-45.

August Heinrich Rudolph

V.—GRISEBACH'S REPORT ON GEOGRAPHICAL BOTANY FOR 1844.

VI.—GRISEBACH'S REPORT ON GEOGRAPHICAL AND SYSTEMATIC BOTANY FOR 1845.

EDITED BY

ARTHUR HENFREY, F.L.S.

&c. &c.

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CONTENTS.

ON THE STRUCTURE OF THE PALM-STEM.

By Prof. H. von Mohl.

ON THE NUCLEI, FORMATION, AND GROWTH OF VEGETABLE CELLS. By Prof. C. Nägeli.

PART II.

ON THE UTRICULAR STRUCTURES IN THE CONTENTS OF CELLS. By Prof. C. Nägeli.

REPORT ON PHYSIOLOGICAL BOTANY for 1844 and 1845. By Prof. Link.

REPORT ON GEOGRAPHICAL BOTANY FOR 1844.
BY PROF. GRISEBACH.

REPORT ON GEOGRAPHICAL AND SYSTEMATIC BOTANY FOR 1845. BY PROF. GRISEBACH.

ON THE

STRUCTURE OF THE PALM-STEM.

BY HUGO VON MOHL.

(The Treatise 'de Structura Palmarum' contained in Martius's 'Genera et Species Palmarum.')

TRANSLATED, WITH THE APPENDIX,

(From the German version, published by the Author, in his 'Vermischte Schriften botanischen Inhalts'—Tübingen, 1845,)

BY ARTHUR HENFREY, F.L.S. ETC.

STRUCTURE OF THE PALM-STEM.

INTRODUCTION.

A minute anatomical examination of the Palms is of especial importance in regard to the anatomy and physiology of plants, because the characters of the Monocotyledons are most clearly exhibited in them, and they therefore afford the most favorable means of acquiring satisfactory ideas of the structure and growth of this great class of plants. As the earlier phytotomists had devoted but little care to the examination of Palm-stems,* these suddenly acquired very great importance when Daubenton, in the examination of the Date-palm, believed that he found the vascular bundles proceeding to the young leaves, becoming developed in the interior of the stem, surrounded by the vascular bundles running to the older leaves. This proposition, forming an epoch in the history of Phytotomy, first appeared in its full importance when Desfontaines† showed that, not only in the Date-palm, but in Monocotyledons generally, the wood has the form of scattered vascular bundles, and that the vascular bundles which run to the leaves come from the centre of the stem. This

* Vide Grew's Examination of Calamus, Anat. of Plants, p. 104.

† Mém. sur l'Organisat. d. Monoc. (Mém. de l'Institut National, t. i, 478). According to a brief notice published by Mirbel (Comptes Rendus, 12 Juin, 1843), the first discovery belongs to Desfontaines, he having already, in his 'Travels in Algiers,' expressed in a few words the idea which lies at the foundation of his system.

discovery necessarily excited the greatest attention; the doctrine, that the vascular bundles of the Monocotyledons originate in the centre of the stem, and press the older bundles outward; that this process continues until the older and solidified vascular bundles form a layer at the circumference of the stem sufficiently firm and hard to resist the pressure of the younger; that thereupon all further increase of thickness of the stem must cease, and that from this results the columnar form of the stem—this doctrine appeared to explain the peculiarities of the growth of Monocotyledons in a manner so simple and satisfactory, that it not only passed into all text-books, but was even used by De Candolle for the systematic division of vascular plants into Endogens and Exogens. The observations of Dupetit-Thouars* showed, indeed, that the stem may grow to an unlimited thickness in many Monocotyledons; they were not, however, any more than the later observations of Mirbel, sufficient to shake the belief in the correctness of Desfontaines' doctrine, and only gave occasion for the assumption that in some Monocotyledons a second peripherical growth occurs, in addition to the central vegetation. One voice, alone, but therefore the more important, declared against the theory of the central growth of Monocotyledons.† Moldenhawer stated that in the stem of *Phœnix dactylifera* a line of division occurs, on both the outside and inside of which liber-bundles are equally developed; that around those in the latter situation, spiral vessels are produced subsequently to their first formation, and they thus become ligneous bundles; and that of these ligneous bundles, the inner run to the older leaves, and the outer to the younger; that consequently, in other words, the date-palm has a peripherical growth. Like so many other admirable remarks of this exact observer, this proposition was so completely neglected by other vegetable anatomists, that not one thought it even worth the trouble of mentioning.

* Premier Essai sur la Végétation.

† Beiträge zur Anatom. d. Pflanzen, 53.

ON PALM-STEMS.

Form of the Palm-stem.

The organization of the Stem of Palms undoubtedly exhibits common characters throughout all species: it is simple (except in *Hyphæne*), almost cylindrical, generally upright, encircled by the scars of the leaves which surround the stem, but without true nodes; fixed to the earth by slender fibrous roots; having at the apex a tuft of leaves, in the axils of which stand the spadices. The internal structure is, generally speaking, as follows: the groundwork of the whole stem is an uniform, lax parenchyma, in which lie, scattered irregularly, slender vascular bundles, running apparently parallel with the axis of the stem; those lying nearest to the circumference of the stem are mostly thicker, of a more woody consistence, and placed closer together than those situated in the interior; from this circumstance, the stem often possesses very considerable solidity toward the periphery.

For the convenience of anatomical description, I divide Palm-stems into some subdivisions, which, however, do not correspond to the systematic subdivisions based on the modifications of the structure of the flowers and fruit.

1. The *Cane*-like (*Geonoma*-like) palm-stem, *Caudex arundinaceus*, is thin, slender, upright, with the nodes tolerably near together, the internodes obconical, the epidermis smooth, shining, and not decaying from the action of the atmosphere. These stems are moderately strong, the parenchyma is simple and close, the fibres lying in the middle of the stem softer, those at the circumference often pretty hard, the liber-like layer weak. At first sight, these stems bear much resemblance to the stems of Grasses, especially of bamboo, to which the yellow colour acquired on drying, and the obconical form of the internodes, which give the stem an articulated aspect, much contribute; they are, however, easily distinguished from the culms and subterraneous stems of Grasses, by the absence of a central cavity, and by the circumstance that the vascular bundles do not form any reticularly branched interlacement at the nodes. This stem occurs in most species of *Geonoma*, many species of *Bactris*, in *Hyospathe*, *Chamædorhea*; similar forms, but

constituting the transitions to the other forms of stems, are found in *Desmoneus*, *Rhapis flabelliformis*, and *Corypha frigida*.

2. The *Calamoid* stem (*Caudex calamosus*) resembles the cane-like, but is distinguished by the extraordinary length. The internodes are from two to six feet long, thin, apparently cylindrical, but equally obconical; the surface smooth, shining as if varnished; of a stony hardness. The substance is not firmer at the periphery than in the middle; the vascular bundles are distributed almost uniformly throughout the whole stem; the woody mass is moderately hard, exceedingly elastic, and tough; the external fibrous layer is very thin; the stony, hard epidermis splits off in scale-like pieces when the stem is bent. This form occurs only in *Calamus;* the transition to the cane-like stem is through *Desmoneus*.

3. The *Cylindrical* (*Mauritia*-like) stem is remarkable for its beautifully regular uniformity and smooth, round form. The internodes are pretty long and cylindrical; the leaf-scars are narrow and do not form knot-like projections; the rind thin, not much affected by the action of the atmosphere, often clothed with spines. The internal structure is very strongly marked; almost the whole mass consists of a weak, lax, pith-like parenchyma, in which lie vascular bundles of herbaceous softness. Firm woody vascular bundles are only found at the periphery in a narrow circle; but on account of their frequently considerable thickness and hardness, they form an almost impenetrable layer. The external fibrous layer is mostly very thin. This form occurs in *Mauritia* (*armata*, *vinifera*), *Œnocarpus* (*minor*, &c.), *Kunthia* (*montana*), *Astrocaryum* (*vulgare*, &c.)

4. *Cocos*-like stem (*Caudex cocoides*). This is thick, and somewhat irregularly knotted from the closely approximated, broad leaf-scars, and frequently shaggy with the vascular bundles of the fallen leaves and withered leaf-sheaths; often very tall. The vascular bundles are distributed almost uniformly throughout the whole mass; those situated near the periphery are merely a little more closely approximated than the internal, and are rather thinner than thicker than the latter. The liber-like fibrous layer is very thick; the rind thick, irregularly torn, and weathered. The ligneous bundles are sometimes rather soft, as in *Corypha cerifera*, but also sometimes very hard, as in *Cocos coronata*. On account of the uniform distribution of the vascular bundles, the stem is nearly as hard in the middle as in the outer part, and on account of the great number of bundles, it presents considerable solidity. This form of stem occurs in *Cocos*, *Leopoldinia*, *Syagrus*, *Elais*, *Corypha; Rhapis flabelliformis* and *Lepidocaryum gracile* form the transition to the cane-like stems.

5. Stemless Palms. In some the length is so small that the plants seem to be stemless. Two varieties occur. In the first the stem is abbreviated, like a bulb. This is not peculiar to any special genus, but occurs in individual species of the most varied genera, e. g. in *Geonoma acaulis*, *macrostachys; Astrocaryum acaule*, *campestre; Diplothemium maritimum*, *campestre*, *littorale*.

Isolated species occur with stems sometimes very much abbreviated, and at other times of tolerable length, e. g. *Attalea compta*. The second variety occurs in *Sabal;* here the stem forms a short, creeping rhizome, of a most remarkable form, its leafy apex lying on the ground, while the hinder extremity is lifted up by the roots, and projects above the ground.

Note.—I had no specimens of this fifth form to examine; the following remarks relate, therefore, only to the first four forms of stems mentioned.

Course of the Vascular Bundles in the Stem.

Before I proceed to the microscopic anatomical description of the stem, it will be necessary to describe the course of the vascular bundles. It is known that these do not lie in concentric circles, but are scattered without definite arrangement throughout the stem. This difference of the Palms from Dicotyledonous trees is so striking, that even in ancient times it was regarded as a characteristic peculiarity of Palms.* The course of the vascular bundle is best traced in stems where the parenchyma has lost its firmness by decomposition; in these the individual bundles may with very little trouble be extricated from a stem split longitudinally. Stems with a white pith-like centre are also very well adapted to this investigation. When, in such a stem, e. g. *Kunthia montana*, a vascular bundle is traced from the point of insertion of the leaf backward, it is found that it runs in a curve (the convexity upward,) to the centre of the stem, then in the neighbourhood of the centre runs down a certain extent deep in the stem, but soon again loses the direction parallel to the axis of the stem, gradually (since at the same time it is always running down the stem) again approaching the surface, till it lies beneath the rind, and there passes down the stem beneath this.

Obs. I have here described the course of the vascular bundle in the direction from above downward, because I usually traced them in this

* Theophrast., Hist. Plant., lib. i, cap. ix.

direction in the stem; but it must not be hence inferred that the vascular bundle of Palms is perfected in this direction in its formation; and in the following pages I shall, according as it may be more conveniently stated, follow the vascular bundle, in the anatomical description, sometimes from above downward, and sometimes in the opposite direction.

The course of the vascular bundle is the same in all Palms, and the only distinctions which present themselves are a difference of aspect at different points of the course of the vascular bundle in different species.

In those species, for instance, which, like *Kunthia montana* and *Mauritia aculeata*, possess firm woody vascular bundles only at the periphery of the stem, with a centre composed of soft, herbaceous substance, we find that all the bundles are thin, soft, and herbaceous from the point where they enter the leaf, downward to the centre of the stem, and from here outwards to the point where they approach the outer hard, woody layer, and that as they proceed downward in their course in that layer, they gradually become denser, and of a firm ligneous consistence. When the vascular bundles have reached the external part of this layer, and become situated beneath the rind, their thickness is diminished, but not their firmness and hardness; the latter peculiarity, however, is less remarkable, on account of their smaller diameter. They run in this manner, in the form of slender fibres, between the firm, woody layer and the rind, to the base of the stem, or terminate, after a course of variable length, in other vascular bundles, becoming blended with them. As all the vascular bundles have a similar course, and the portion running in the middle of the stem is soft and herbaceous in all, the medulla-like softness of the centre of the stems is easily explained. It is also clear that the hardness of the outer layer of the stem results from the thickness and solidity acquired by the collective vascular bundles during their course through this outer layer; further, that the liber-like fibrous layer under the rind is formed by the lower extremities of the vascular bundles, and is not to be compared with the liber of Dicotyledons.

The vascular bundles of the *Cocos*- and *Calamus*-like stems are distinguished by their not exhibiting that herbaceous softness in their course from the leaf to the centre, and from this to the outer layer of the stem, for they also appear thick and woody here, although in a less degree than in the outer layers. With regard to the inferior portion of the vascular bundle, two varieties are met with in the *Cocos*-like stem: it either passes, as in *Kunthia*, into a thin fibre, and the external fibrous layer of the stem is then thin, as in the rest of the forms, or the vascular bundle divides, at its exit from the hard layer, into several smaller bundles, which, after a short course, lose themselves in a multitude of fine fibres; the fibrous layer is then thick, as, for instance, in *Cocos nucifera*, *coronata*, &c.

From this course of the vascular bundle is deduced the following statement: *The doctrine laid down by* DESFONTAINES, *that the new vascular bundles originate in the centre of the stem, and that the harder and thicker vascular bundles, situated at the periphery of the stem, are older than the soft ones occupying the centre, and that, therefore, the vegetation of Monocotyledons is wholly different from that of Dicotyledons, is altogether incorrect and inadmissible.*

Obs. 1. From the circumstance that the vascular bundles run from the leaves to the middle of the stem in a curve of small radius, but that from here, in their way downward, they only approach the rind gradually, we can understand how phytotomists have been led to assume that they originate in the middle of the stem. Indeed, this outward course is not easily observed in a stem split longitudinally, unless the single vascular bundle is dissected out. One circumstance, however, must have long since indicated the incorrectness of Desfontaines' doctrine. If, namely, the vascular bundles of the younger leaves lay more internally in the stem than those which go to the older leaves, the former could never cross the latter. Now, it is easily seen in all Palms, that the vascular bundles entering a leaf, cross those which run to the leaves situated higher up, which is only possible by the arrangement of the fibres described above. This crossing is the more striking the thicker the stem and the closer its leaves, therefore much more evident in the species of *Cocos* than in *Kunthia*; it is still more distinct in *Xanthorrhœa hastilis* (vide De Candolle, Organogr. tab. 7, 8), in a transverse section of

the stem of which the vascular bundles entering the leaves have the aspect of medullary rays. The crossing is also very evident in the stem of *Pandanus, Dracæna Draco, Aletris fragrans, Aloë, Bambusa*, &c.

Obs. 2. The smaller diameter of the lower liber-like end of the vascular bundles simply explains the less degree of thickness of the fibrous layer of the stem. Where each vascular bundle ends in a single filament, as in *Bactris, Geonoma, Lepidocaryum, Calamus, Kunthia, Œnocarpus, Hyospathe, Rhapis*, &c., this layer is very thin; when, on the other hand, the vascular bundle gives off several fibres, or when, as in *Mauritia vinifera*, the fibres retain a considerable thickness, the thickness of the fibrous layer is not altogether inconsiderable. I found it in *Leopoldinia pulchra* from ½ to 2 lines; in *Syagrus cocoides* 1 line; in *Cocos nucifera, Euterpe edulis, Mauritia vinifera*, 6 lines thick.

The Cellular Tissue of the Palm-stem.

The cellular tissue is not, as in Dicotyledons, distributed into distinct bark, pith, and medullary rays, since the vascular bundles are scattered throughout the whole substance of the stem. Nevertheless, the cellular tissue exhibits different forms in the different layers of the stem, which may in many respects be compared with the forms of the cells of the bark, pith, and medullary rays.

The form of the cellular tissue in Palm-stems in general possesses but one definite character, namely, it is parenchymatous, and its cells are usually arranged in perpendicular rows, the forms of these cells varying much, not only in different species, but in different layers of the same stem. In general, these cells are only of a medium size, and apparently in all species, at a certain period of vegetation, densely filled with starch.

In the fibrous layer, the cellular tissue is composed of small, thin-walled cells, mostly expanded transversely, between which are small intercellular passages. In young stems, the cortical layer of which is still in full vegetation, chlorophyll-granules are found in the outer cells, starch-granules in those lying deeper; the granular formations subsequently disappear. The cells of this layer only

form a perfectly regular tissue where the fibrous bundles lie far apart; in most cases the regularity of their arrangement is destroyed by the cells lying next the vascular bundles having their broad side, or more rarely their narrow side, directed towards the vascular bundle, in which latter case a stellate figure is formed round each bundle (*Leopoldinia pulchra*).

In that layer of the stem in which lie the thick, hard vascular bundles, the cellular tissue becomes compressed into thin lamellæ, from the vascular bundles lying very densely crowded here, and by their mutual pressure frequently (especially in cylindrical stems) forcing them to assume an angular figure; these lamellæ indeed have a very variable direction according to the form of the vascular bundle, but taken as a whole, run from without inward, since the vascular bundles mostly exhibit a form compressed on both sides. The cells are also here transversely expanded in the direction of the lateral faces of the vascular bundles, and so much the more, the nearer they lie to the vascular bundles; therefore they have in the cylindrical stems, in which at most only 1 to 3 rows of cells lie between every two vascular bundles, a very much elongated form, while in other stems this only occurs from accidental approximation of vascular bundles, and the dodecahedral form of the cells reappears in all places where the vascular bundles lie further apart. In proportion as the cells assume a transversely extended form, the superposition in perpendicular rows becomes converted into an arrangement in horizontal rows, so that the cellular tissue assumes the so-called muriform character. In many Palms, e. g. *Cocos botryophora*, the outer vascular bundles stand behind one another in radiating rows, so that broad strips of cellular tissue penetrate from 1 to 3 lines deep into the stem in the form of medullary rays. In these strips, the cells exhibit lateral expansion parallel to the surface of the stem.

The cells of this layer almost always have much thicker and harder walls than those of the fibrous layer and the

interior. The thickening of their walls is usually indeed, although always noticeable, not very striking, but in certain Palms, on the contrary, e. g. *Diplothemium caudescens*, *Cocos botryophora*, they attain such thickness as we are only accustomed to see in wood- and liber-cells. In consequence of this thickening of the walls, the dots (which in general occur in all Palm-stems) are converted into distinct canals, which correspond in contiguous cells. In these two conditions, the thickening of the walls and the punctation, these cells approach no less than in their form, the cells of the medullary rays of Dicotyledonous trees, since these also are constantly thick-walled and punctated.

The cellular tissue of the central part of the stem exhibits in like manner many variations, which in great part are connected with the position of the vascular bundles. In all Palms it agrees in these characters—the cells are thin-walled, in most cases arranged in perpendicular rows; the cells lying upon the vascular bundles are mostly somewhat elongated, and depend for the direction of their transverse diameters on the position of the vascular bundles.

In the interior of the *Cocos*-like stems, the cellular tissue exhibits a regular parenchyma, the cells are thin-walled, finely punctated, and only in the investment of the vascular bundles, or where two bundles lie near together, do they form transitions to the muriform cellular tissue, without, however, thereby acquiring thicker walls; in *Cocos botryophora* and *Diplothemium caudescens*, the cellular tissue even becomes thinner-walled the nearer it lies to the centre.

In most Palm-stems, on the other hand, in which the vascular bundles stand much further apart in the middle than at the circumference, the cellular tissue of the centre exhibits considerable differences from that of the outer layers, becoming very lax, and this in two ways.

In some cases the cellular tissue in the middle of the stem has very large cells, and thus forms a very soft,

spongy mass; e. g. in *Geonema simplicifrons*, *Œnocarpus minor*, *Kunthia montana*. In these instances only the smaller cells, forming the boundaries of the vascular bundles, retain the form of regular parenchymatous cells; the rest, very much enlarged, run out in a radiating direction from the vascular bundles, and form as many stellate rosettes as there are vascular bundles. In other cases, the cells in the central portion of the stem do not attain to such considerable dimensions; but the tissue is rendered lax by the intercellular passages becoming enlarged into regular air-canals. *Calamus* forms the transition here, in which large intercellular passages occur between the cells in the middle of the stem; these, however, still preserve too much of the form of regular parenchymatous cells, and the intercellular passages are still too small, to allow of our properly reckoning this cellular tissue under the so-called compound form. This occurs to a great extent, however, in *Astrocaryum gynacanthum*, *vulgare*, *Mauritia vinifera*, and especially in *Mauritia armata*. Here the cells leave between them large roundish canals, which run in unbroken continuity through long tracts in the stem, so that one can blow smoke through pieces of the stem more than a foot long. At the extremities these canals are gradually attenuated till they become completely closed, for the septa of stellate cells, such as are found in many aquatic plants, in *Musa*, &c., do not occur in the Palms.

Obs. 1. Certain German phytotomists (Heyne, Meyen) have recently sought to distribute the cellular tissue into a great number of subdivisions, according to the form of the cells; this appears to me contrary to nature, on account of the abundance of intermediate conditions between all these forms. The above description of the cellular tissue of the Palm-stem may serve as a testimony that the form of the cell stands in no close connexion with its function, and that it depends quite as much upon the form, organization, and position of the adjacent cells and vascular bundles, as on the special nature of the cells. In comparing the stems of different Palms it is unmistakeable that cells, lying in corresponding places in different species, which have a similar import in the economy of the plants, exhibit wholly different, often variable forms, and it therefore appears quite improper to attach so much importance to the form of the cells.

The Palms are the more fitted to afford this evidence, since the plants not only form one of the most natural families, but also manifest a very great similarity, both in respect to their vegetation and their products. The same conditions, deviation of form of the cells in nearly-allied plants, may also be demonstrated in other no less natural families, for instance, in the Ferns.

2. I did not find raphides or other crystals in the cells of any Palm-stem.

The Palms have not a *bark* distinctly separate from the subjacent parenchyma, and exhibiting a special growth, such as occurs in Dicotelydonous trees; but the outer layers of the cellular tissue are remarkable, and therefore deserve description. In the young condition they have thin walls, and cannot be distinguished from the cells of the subjacent fibrous layer; in more advanced age, however, their walls are thicker, and become hard and brown. In many species—for example, in *Calamus*, in many species of *Geonema*—this layer remains very thin; its cells do not acquire such thick walls, and appear to retain their vitality throughout the whole life of the plant. In other species, on the contrary, the surface of which is subject to destruction by atmospheric influence, as in *Cocos*, *Elais*, the rind acquires a considerable thickness, and gradually draws a portion of the fibrous layer into its circle. In such case this is not of equal thickness at all points of the circumference of the stem, but passes deeply into the fibrous layer in particular places, while in other situations it is rather thin. Under these circumstances, the inner layers of the rind inclose a portion of the fibrous bundles, which is not usually the case.

The *epidermis* exists in old age only in the cane-like and calamoid stems; in the rest, it is more or less destroyed by the action of the weather. It consists of a simple layer of minute cells. As a general rule, no stomates occur in it, but they do exist scattered in *Rhapis flabelliformis*. In *Calamus*, it consists of minute cells elongated in the direction from without inward, and forms a stony, brittle, shining layer.

The different kinds of pubescence also come under consideration as appendages of the rind and true cellular

parts. The youngest portion of the stem is frequently clothed with a hair-like covering, so long as it is still young and inclosed by the leaf-sheaths. Sometimes this appears in the form of actual hairs, which are mostly closely crowded and coherent into a dense felt; e. g. in *Bactris tomentosa*. In other cases, the covering is composed of scales (*ramenta*), which exactly resemble those of the Ferns; e. g. in *Rhapis flabelliformis, Phœnix dactylifera*. In other instances the cells are combined into spines of various dimensions. On the leaf-sheaths and spathes many transitional forms are met with, from simple hairs, stiff bristles, to strong, hard spines. Spines of this kind exist on the stems of many Palms, lying closely appressed to it, so long as the internodes are included in the leaf-sheaths; but erecting themselves after the fall of the leaf, they form a terrible defence to the stem by their hardness, length, and prickly points.

The spines are sometimes blunt cones, but about an inch long, as in *Mauritia armata*; in *Acrocomia sclerocarpa, Astrocaryum Murumurù, Ayri, gynacanthum*, &c., on the contrary, they form long, slender, very hard and acute needles. These are only cellular structures; the cells of the outer layers are elongated, hard, and have very thick walls, those in the middle are thin-walled and parenchymatous; the middle of the spine is often hollow.

Structure of the Vascular Bundle.

Before I describe the modifications which the structure of the vascular bundle undergoes in the different parts of its course, it may not be out of place to state its composition in those situations at which, from the hard peripherical cylinder of wood, it enters, on its way to the centre, the soft middle substance of the stem. It here consists of three constituents, which may be clearly distinguished from each other: 1, of liber; 2, of a bundle of proper vessels (*vasa propria*); and 3, of the ligneous

body. These three constituents are constantly applied together in such a way that the liber is directed toward the periphery, the wood toward the centre of the stem, and the proper vessels lie between the liber and wood. As a general rule, the following is the minute structure of the different portions.

The *liber* (Bast) consists of thick-walled, prosenchymatous cells. The opinion of Kieser, therefore (Phytotomie, 209), that the liber-cells of the Monocotyledons have horizontal septa, was altogether unfounded; and indeed Moldenhawer (Beiträge, 48) had already found a prosenchymatous liber in the Grasses. The liber-cells manifest no definite arrangement in their corresponding positions; those lying toward the interior of the vascular bundle are of the smallest diameter. They have fine dot-canals (Tüpfelcanalen, canals of the pores).

The *proper vessels* are composed of a combination of much elongated cells, with horizontal septa, thin walls, and of various diameter. The narrower lie partly between the angles of the wider, partly between the lateral walls of the others.

The *wood* consists of elongated parenchymatous cells, with thin walls, and porous, among which, on the side directed toward the periphery of the stem, usually lie two large reticulated vessels, and behind these a variable number of narrower spiral and annular vessels.

The structure described is not retained unaltered by the vascular bundle throughout its whole length, but its structure changes in the different parts of its course in an analogous manner in all Palms. To demonstrate this, two methods may be adopted, to investigate either the transverse section of an entire stem, or an isolated vascular bundle in the different parts of its course.

In the investigation of the transverse section of a Palm-stem, we can indeed become acquainted with the structure of any one of its vascular bundles only at one point of its course; since, however, each of these vascular bundles has a definite course from the periphery to the

centre, and from this again outwards to the periphery, it is clear that in every transverse section of the stem we must meet with the fibrous inferior extremities of the vascular bundles at the periphery; further in, the thick and hard part of the bundles formed further up; and toward the middle of the stem, the soft part of the bundles in the situation of their more vertical course beneath their point of curvature; finally, we may meet with the portion of the bundles, in which they run from the centre toward the leaves, in the most varied situations, among the others. The last vascular bundles will be cut through more or less obliquely, the rest in pretty nearly a fair transverse section.

The examination of such a transverse section by the microscope, shows that the outer fibrous bundles are composed solely of thick-walled prosenchymatous cells, which correspond to the liber-cells of the other vascular bundles. More toward the interior, we meet with large bundles, which already exhibit the perfect composition of the vascular bundle; they are distinguished by their liber-mass being relatively very large, and by having the wood consisting of a single vessel surrounded by but few cells. The proper vessels likewise exist only in small numbers. Further inward, where the vascular bundles have attained their most considerable size, they are composed in greatest part of thick-walled, lighter or darker brown cells, the wood is still but slightly developed, yet contains already one or two vessels of tolerable size, which are inclosed by few, somewhat thick-walled, cells; the proper vessels are also but little developed, and are readily distinguished from the wood-cells by their thinner walls. Still further inward, in the transition to the soft part of the stem, the size of the vascular bundles diminishes; they exhibit a rounder form, since the liber-mass is considerably smaller and assumes the form of a crescent, in the concavity of which the proper vessels are received, and behind these lies the strongly developed woody portion. In this occur one or two large vessels, with several smaller behind them. The

nearer to the centre the vascular bundle lies, the more the liber is diminished in mass, till at last it displays only a very thin crescent, while the size of the woody mass increases in the inverse ratio, the smaller vessels lying at its inner side increasing in number. The bundle of proper vessels enlarges in similar proportion to those of the woody mass. The softness of the whole vascular bundle increases with the diminution of the mass of the liber, because the liber alone contains the thick-walled elementary organs.

Similar changes in the structure of the vascular bundle are met with, when it is dissected out from the stem and examined in different parts. In this way we may not only obtain, by comparison of transverse sections of one and the same vascular bundle, a survey of the changes of its size and structure which leaves no room for doubt, but we may detect more readily than in the cross section of an entire stem, the changes which the vascular bundle undergoes in its way from the centre of the stem to the base of the leaf.*

These changes are as follows: the nearer the vascular bundle approaches to the leaf, the more the liber-mass diminishes in size and the woody portion increases, a great multiplication of the vessels of the latter being connected with this, these, however, considerably decrease in size. In the vicinity of the point of emergence from the stem, a division of the vascular bundle into several (up to six) portions already begins to be effected, this taking place in such a manner, that small bundles of liber appear on the outer borders of the woody portion, at its posterior and lateral surfaces, behind which, and at some distance higher up, are found the rest of the systems (wood and proper vessels) belonging to a perfect vascular bundle, so that the entire vascular bundle consists of a circle of smaller bundles, which all have their woody por-

* What relates to these two methods of investigation is not a translation of the original text, for the latter referred specially to the illustrations here, and therefore would be incomprehensible without them. (H. v. Mohl.)

tions directed toward a common centre, and by the simple separation of these subdivisions, it becomes decomposed into just so many bundles containing all the essential parts of the vascular bundle.

From the character of the vascular bundle, as above described, follows incontrovertibly the total falsity of the generally received opinion, that the thicker and firmer vascular bundles lying in the outer parts of the stem are the older and lignified, and that the softer, lying in the middle, are the younger, not yet come to their complete development.

*Modifications of the Structure of the Vascular Bundle in various Palm-stems.**

Although the structure of the vascular bundle exhibits a common type in all Palms, modifications occur in the different species.

In the cane-like stems, the liber of the outer hard layer of the stem displays a very considerable development; toward the centre it, indeed, diminishes again in volume, yet still retains a moderate size, and since the the vascular bundles are not very distinct from each other, the middle of the stem possesses tolerable solidity.

In the cylindrical stems, the liber of the outer layers exhibits the greatest development that occurs in the Palms, into a mass often elongated in the direction from within outwards; in the middle of the stem the vascular bundle acquires an herbaceous softness, partly through the diminution of the liber-bundle, partly through the walls of its cells becoming so very thin, that in a cross section they resemble parenchyma-cells.

In the cocos-like stems the liber only increases slowly in the passage of the vascular bundle from the fibrous layer toward the interior, and does not attain any considerable size; the vascular bundles of the outer parts of

* This portion consists of extracts, since the detail in the original referred to the illustrations. (H. v. Mohl.)

the stem are also in a less crowded condition than in the two preceding forms. Partly by this, and partly by the smaller amount of decrease of the liber in the middle of the stem, is explained the more uniform hardness of the different layers of the latter.

The vascular bundles of *Calamus* exhibit a very peculiar structure. The liber is here also strongly developed in the outer layer of the stem, but the woody portion displays this peculiarity, that, disregarding rare exceptions, instead of several large vessels, it contains only one of unusual dimensions, occupying the centre of the bundle. Behind this large vessel (except in the outermost vascular bundles) lie small spiral vessels. The cells of the woody portion have thick walls, and thus may readily be confounded with the liber-cells in a cross section. The proper vessels are distributed in two groups, which, with the spiral vessels, form as it were the points of a triangle inclosing the large vessel.

Of the Structure of the particular Anatomical Systems of the Vascular Bundle.

The cells of that part which I denominate *liber* always have a diagonal septum. In a young condition, they, like all other thick-walled cells, are composed of delicate, colourless membrane. When with increased age they have become thicker, they afford clear evidence that the membrane of the vegetable cell grows in thickness by the deposition of layers. In transverse sections of the walls of the liber-cells of all Palms, delicate concentric lines may be seen, and that these lines form the boundaries of the different layers composing the cell-membrane, is manifest from the fact that sometimes, when the section has been made with a razor which is not very sharp, these layers separate from each other, and the slice of cell-membrane appears in the form of distinct concentric rings. Frequently the colour of these cells is not uniform throughout the whole thickness of the membrane, and

some of the component layers are often of a darker hue than the rest.

A second remarkable peculiarity of these cells is their porosity. Both in the transverse and longitudinal sections we see fine striæ, which run from the cavity toward the outer surface of the cell. When a high magnifying power is used, there remains no doubt that these striæ are canals perforating the cell-wall. As a general rule, their diameter does not exceed $\frac{1}{2000}$ of a line. As in the case of the pores of cellular tissue, the canals of adjacent cells correspond to each other.

The second constituent of the vascular bundle, which I have termed *wood*, is composed of two organic systems, cellular tissue and vessels.

The cellular tissue of this woody portion consists of colourless parenchymatous cells, the walls of which are not very thick. They are usually somewhat elongated, stand in vertical series one above another, with horizontal septa; never lie in series diverging like a fan from the hindmost point of the woody mass, but form an irregular parenchyma, the cells of which, in the vicinity of the vessels, are arranged according to the form and position of these latter. These cells never contain starch-granules; their walls are studded with large and small pores like the cells of *Cycas*.

The woody mass, as already mentioned, always lies at the inner side of the vascular bundle; but in the transition of the fibrous bundle, devoid of vessels, into the condition of vascular bundle, it is very frequent, and almost the rule, for the woody mass to lie, not at the inner side, but in the middle of the liber-bundle. In the vascular bundles of the outer, hard layers of the stem, also, a narrow strip of liber-tubes often runs round the posterior face of the woody mass, so that this is completely surrounded by liber-tubes.

In other cases the membrane of the wood-cells is itself thickened, and thus they acquire a resemblance, at least in the cross section, to the liber-cells; however, they are

mostly to be distinguished from these by their larger cavity and somewhat thinner walls, and in the longitudinal section by the septum being, at all events in the vicinity of the vascular bundle, horizontal. This thickening occurs sometimes here and there in the outer bundles of many Palm-stems, e. g. in *Kunthia montana,* in which case it is met with in one vascular bundle and not in the others; or it is a structure occurring regularly in all bundles, which, however, is only the case in *Calamus.* Notwithstanding that there is here a great similarity produced to the liber-cells by the thickening of the walls, they may be distinguished from these by the somewhat thinner walls, a larger cavity, as well as by the circumstance that, with the exception of the hindermost, they are elongated in a direction parallel to the wall of the large vessel. Their walls, like those of the liber-tubes, consist of several layers, and possess pore-canals, which are particularly striking in longitudinal sections, since from their small distance from each other, the cell-wall cut through possesses almost a moniliform aspect; and under these circumstances the nature of these canals, as excavations perforating the cell-wall down to the outermost layer, may be recognised most clearly.

The *vessels* of the Palms must be divided into the large and small. Each of these kinds, as is clear from what has been said already, occupies a definite place in the vascular bundle. The large vessels, traced from the lower fibrous extremity of the vascular bundle to its exit into the leaf, do not anywhere exhibit the form of the spiral, but that of the scalariform or reticulated vessel. These vessels are composed of rather short tubes, standing one above another. This composition may be perceived even by the naked eye in the very wide vessels of *Calamus Draco, Mauritia vinifera,* &c., the length of one of the tubes in these plants amounting to 1—2 lines. The face where the ends of the tubes meet one another is very seldom horizontal, but mostly inclined considerably toward the axis of the vessel. As a general rule, the ends

of the tubes do not lie one behind another in the direction of a line drawn from the periphery to the centre of the stem, but side by side. The tubes do not always succeed one another singly in the longitudinal arrangement, for frequently two or three stand next below a single one, so that in the cross section there appear to be 2—3 vessels side by side. This occurs sometimes even low down in the vascular bundle, in which case these vessels often again blend into a single one. Some of these vessels attain a very considerable size. In the lower part of the course of the vascular bundle, they have indeed scarcely a diameter of $\frac{1}{200}$ of a line; but the vessels occurring in the middle tract are among the largest that are met with in the vegetable kingdom: thus the vessels of *Bactris mitis* exhibit a diameter of from $\frac{1}{30}$ to $\frac{1}{25}$ of a line, those of *Desmoneus mitis, Œnocarpus minor*, $\frac{1}{23}$ to $\frac{1}{17}$, of *Astrocaryum gynacanthum* $\frac{1}{17}$ to $\frac{1}{12}$, *Corypha cerifera* and *Mauritia armata* $\frac{1}{13}$ to $\frac{1}{10}$, *Mauritia vinifera* $\frac{1}{8}$ to $\frac{1}{6}$, *Calamus Draco* $\frac{1}{7}$ to $\frac{1}{5}$ of a line.

The walls of these vessels universally exhibit the form of a dotted tube.* But the nature of this varies according to the nature of the adjacent parts. As this circumstance has almost entirely escaped phytotomists, a more minute exposition of it may not be out of place here. I have already pointed out, that in cellular tissue the position of the pores of one cell exerts a definite influence over the position of the pores of the adjacent cells, and that the pores of two contiguous cells always correspond. Now this occurs also in the reticulated vessels. It is a universal law in the reticulated vessels and scalariform ducts of all plants, that the dots and slits of their walls are somewhat shorter than the breadth of the cell or vessel in contact

* In the Latin original I have called them *vasa porosa, v. punctata,* because the term reticulated vessel did not appear to me adapted to the kind of punctation. But since I have subsequently found that the pores of dotted vessels of the Dicotyledons are distinguished from those of the vessels of Palms, by the fact that there is a cavity between each pair of pores in the former, which is wanting here, I now select the expression reticulated vessel, to avoid the necessity of making a new term.

with them. Since, as a rule, the vessels are surrounded by elongated cells, and the lateral walls of these cells, perpendicular to the vessel, run down some distance vertically upon it, this causes the well-known appearance that the dots or slits lie in a straight row, one above another, in the vessel. In the Palms, the vessels are, in most cases, surrounded by short, dodecahedral parenchyma; since, therefore, in accordance with the above law, the pores are only formed at those places in the vessel at which the parallel walls of the neighbouring cells are grown to the wall of the vessels, these vessels exhibit an apparently irregularly grouped distribution of the pores and, between these groups of pores, free interspaces, which correspond to the perpendicularly-placed side and cross walls of the adjacent cells.

In other cases, where elongated cells are in contact with the vessel, the pores lie in regular vertical rows. When two vessels are directly applied together, the pores of the lateral walls, grown to the other vessel, assume the form of transverse slits, which are as long as the breadth of this wall, whereby the vessel becomes scalariform, while the other sides, in contact with cells, possess the form of the reticulated tube. These relative conditions are not peculiar to the Palms, but occur in the same manner in other plants, for instance, most distinctly in the Tree-ferns.

Obs. It is further to be noticed, that cases also occur in which the pores have not the whole breadth of the adjacent elementary organ. For instance, it not unfrequently happens that the pores are a good deal shorter, and lie in regular horizontal lines, intermingled with longer slits. I found a peculiar deviation from the general rule, that the pores of two adjacent vessels correspond exactly in position, form, and size, in *Corypha cerifera*, where one vessel was studded with longer slits, while the other possessed rows of roundish or elliptical pores corresponding to these slits.

Both the investigation of full-grown vessels and their development, presently to be discussed, prove that the pores and slits are not actual openings, but are closed by a delicate membrane at the outside. This may be

perceived most clearly when a longitudinal section passes through the adjacent walls of two scalariform ducts, in which case we recognise distinctly that the slits are actual excavations in the walls of the vessels, and not elevations, as stated by Bernhardi (Ueber Pflanzengefässe, p. 35), Treviranus (Beiträge, p. 22), and Meyen (Phytotomie, p. 253), but that the interspaces between the slits form elevations which project into the vessel. It may likewise readily be perceived that a membrane is stretched between the fibres, separating the fibres of the two vessels under the from of a simple, dark line. The development of these vessels shows that this membrane forms a tube inclosing the fibres. The pores and slits equally exhibit an evident rim, which does not depend, as Mirbel assumes, on the presence of a projecting border, but is, on the contrary, caused by the borders of the slit being truncated by an oblique surface.

In many cases, as in *Calamus* for example, the place where two vascular tubes are connected is conspicuous, from each tube ending in a broad ring; the two adjacent rings form a band surrounding the vessel, as Moldenhawer has shown long since in other plants. When the tubes meet by such a ring, they are freely open to each other. In other cases, on the contrary, particularly in *Desmoneus mitis*, *Cocos nucifera*, *Mauritia vinifera*, *armata*, *Kunthia montana*, *Astrocaryum gynacanthum*, *vulgare*, *Corypha frigida*, no such rings are seen at the points of connexion of the tubes, and in these are found septa. The existence of such septa is indeed denied utterly by all phytotomists; but having observed them hundreds of times, not only in the Palms, but in many other Monocotyledons, and even in many cases in the porous vessels of Dicotyledons, I do not hesitate to assert their existence in the most positive manner. The direction of these septa is usually such that we obtain a front view of them in a longitudinal section made in the direction of the radius of the stem. They differ completely from all other membranes of plants, in being formed of a reticulation of thick fibres, with large openings between them. In the stems of Palms

where these septa cut the axis of the vessel obliquely, and therefore are elliptical in form, the fibres are mostly horizontal. At the two rounded extremities of the septum the orifices present the form of little slits or round holes, in the middle of broad slits or oval openings, and at both sides of the septum likewise occur smaller, roundish, or ovate orifices. Each of these orifices is bounded by a narrow rim. In other cases, the orifices exhibit the form of narrow, transverse slits, giving the septum quite a scalariform aspect. The openings are usually actual perforations, very rarely a thin membrane is stretched over them. The fibres of the septa are double, and the rim originates from the same cause as in the scalariform ducts. These septa occur very frequently in the Palms; in many species, however, as for instance in *Cocos nucifera*, they do not occur at every point of junction of two vessels, for some of these end in the ring above described. To avoid the necessity of recurring to these septa in the examination of the root of the Palms, I will mention here, at once, that in the large vessels of the roots the septa are usually perpendicular to the axis of the vessel, and therefore of roundish shape. In this case they are not scalariform, but reticulated, perforated by large, roundish, and many small punctiform orifices. The course of the fibres does not always correspond exactly in the two component plates of the septum, whence a portion of one plate often projects into the opening of the other.

In the porous vessels of the Dicotyledons it is well known that vesicular cells often occur, which Kieser believed to be composed of the same membrane which forms the wall of the porous vessel, whence he assumed (Phytotomie, p. 237,) that such vesicles could by no means occur in the Monocotyledons. I however found, though indeed but seldom, vesicular cells, similar to those of the Dicotyledons, in the large vessels of the Palms, for instance, in *Corypha cerifera.**

* I have not traced the development of these cells in the Palms. Doubtless they have the same character as in the Dicotyledons, in regard to which from recent researches, I think that I am not wrong in assuming that they

The course of development of these vessels, which I investigated in the germinating date-palm, in the apex of the stem of *Rhapis flabelliformis*, and in the root of many species of Palms, and with which the development of the large vessels of *Dioscorea*, *Tamus elephantipes*, &c., fully agrees, is as follows: In young shoots, we find in the situation where the large vessels subsequently lie, perfectly closed, large, and cylindrical tubes, which are composed of a colourless and very delicate membrane. In tubes a little older, we find a network of very delicate, transparent fibres upon the internal surface; these have a horizontal direction, are connected at places which correspond to the longitudinal septa of the adjacent cells by perpendicular and oblique fibres. As a general rule, the horizontal fibres are so arranged that they are not continuous over several lateral walls of the vessel, but terminate where they reach a longitudinal septum of an adjacent cell, and here pass into a fibre, going obliquely upward or downward, so that a mesh of a fibrous network comes as a direct successor of the fibre on the adjoining side-wall of the vessel. From this it is most clear that these vessels are not originally spiral vessels, the fibres of which become reticularly connected by the subsequent development of cross-fibres. This is made still more evident by the fact, that in the first origin of the fibrous network, we in many cases meet with the fibres only perfected at particular places, the walls of the vessel appearing still perfectly smooth in other situations. The older the vessel grows, the broader and thicker its fibres become, and the interspaces between them are diminished in width in proportion, till at last they display themselves as mere narrow slits. The septa are perfected in a manner wholly analogous, but the original delicate membrane is generally destroyed, after a time, in the interspaces of the fibrous network.

are produced by a protruding expansion (a kind of *hernia*) of the adjacent cell, which penetrates the pore, and either tears through or causes the absorption of the primary membrane of the vessel.

That these vessels, though not the result of a metamorphosis of spiral vessels, belong to one and the same system, is evident from the fact, that spiral vessels occur in many Monocotyledons in the situation where the reticular vessels lie in the Palms, and in the Grasses, as Moldenhawer showed, the same row of tubes is developed at certain places into spiral, and at others into porous vessels.

The smaller vessels lying behind the reticulated are never reticulated, but always spiral or annular vessels, be the stem under examination as old as it may. The number of annular vessels in each vascular bundle is but small, in general only spiral vessels exist. When annular vessels do occur, they are always situated the farthest back in the bundle, the vessels lying nearer to the large vessels being always spiral. The turns of the spiral are always far apart, especially in those vessels which are farthest from the large vessels. It is easy to satisfy one's self of the presence of an outer membrane inclosing the spiral fibre.

I have mentioned above, under the name of *proper vessels* (*vasa propria*), a bundle of thin-walled cells lying between the wood and liber, as the third constituent of the vascular bundle. This bundle is distinguishable from the surrounding cells, both by the thinner walls of its elementary organs, and by narrow and wide cells lying intermingled in it. This part opposes considerable difficulty to anatomical investigation, on account of its soft texture, and also its great transparency. This circumstance explains why these proper vessels, although they occur in most of the Monocotyledons and in a portion of the Dicotyledons, have been overlooked by almost all phytotomists, for Moldenhawer is almost the only one who was accurately acquainted with them, in *Zea Mays* and *Bambusa*, while Amici saw them in *Calamus*, but did not recognise their nature, and Kieser, who likewise saw them in *Calamus*, explained them as spiral vessels; Bernhardi and Meyen, the latter of whom found these proper vessels in *Scirpus lacustris* and some other Mono-

cotyledons, regarded them as prosenchymatous cells, and distinguished them neither from the liber nor the wood. In a longitudinal section we perceive that the cells are elongated in these bundles, and stand one above another mostly with horizontal septa; the septa are, however, sometimes oblique, and the tubes not unfrequently terminate in a point. We may distinguish narrow and wide cells, frequently with a tolerably strong difference of diameter. Moldenhawer (Beiträge, p. 126) regarded the wider tubes as cells of the usual kind, and the narrow as proper vessels, which he referred to the same system as the milk-vessels of *Chelidonium, Asclepias,* &c. So far as my own investigations showed, I cannot agree with Moldenhawer in this distinction of wide and narrow tubes, for I frequently believed that I saw both containing an opaque, thickish sap, in which swam a great abundance of fine granules; I am, therefore, compelled to refer both to the same system. I never found the contained sap milk-white, but only more or less opalescent. I never could observe any currents, but only an oscillation of the minute granules, which appeared to me merely molecular motion. The septa between the tubes are completely closed. In the stem, the wide and narrow tubes are intermingled without order in the entire bundle, but a different condition will be met with in the root. In *Calamus,* the bundle of these proper vessels is not only divided into two separate portions, but the narrower tubes are frequently separated from the wider, as the latter often lie isolated, at the limit between the wood- and liber-cells.

I have denominated these tubes proper vessels, because the nature of their contents brings them nearest to the system known as the vital (Lebensgefässe) or milk-vessels; I shall bring proofs further on that they are different from this system. In reference to their development, I can merely state that, in the Palms as in other Monocotyledons, they precede the formation of the woody portion in so far that, when a fibrous bundle devoid of vessels

is traced upward to the point where it displays itself as a perfect vascular bundle, they show themselves sooner than the woody mass itself. However, this earlier development relates only to space and not to time. I do not venture to give an opinion as to the function of this system, and for the present am content to have demonstrated their existence anatomically.

Comparison of the Palm-stem with the stems of other Monocotyledons.

With regard to the *course* of the vascular bundle, the Palms stand nearest to *Dracæna, Aletris,* and *Aloë;* with reference to the *organization* of the bundle, to the Grasses.

As to the structure of the vascular bundle of the Grasses, I refer to the excellent researches of Moldenhawer, and merely mention here, that in the Grasses the vascular bundle not only increases in size from the periphery toward the centre of the stem, but its structure is altered at the same time, in a manner analogous to what occurs in the Palms. Beneath the surface of the stem we meet with fibrous bundles without vessels, then fibrous bundles containing a bundle of proper vessels, and these are adjoined by vascular bundles with reticulated vessels, while small vessels occur, in addition, in the inner. The perfect vascular bundles, for example, of *Arundo Donax,* contain two large vessels surrounded by thin-walled wood-cells, behind these lie a row of two or three small vessels; the hindmost portion of the wood-cells is composed of a mass of thick-walled, dotted prosenchyma, as also frequently occurs in the leaves and other organs of the Palms. Between the wood and the liber lies a bundle of proper vessels, the large cells of which are mostly quadrangular, and have a narrower cell lying between their angles.

In *Dracæna* and *Aloë,* the former of which is especially interesting on account of the minute researches on its

growth in thickness by Dupetit-Thouars, we meet with a structure of the vascular bundle which is aberrant in many respects. In a cross section of the stem of these plants, two evidently distinct layers may be detected, the inner being soft and pith-like, and acquiring no increase of size with the age of the plant, while the outer forms a firm mass, and gradually increases in thickness with the age of the plant. Anatomical investigation demonstrates that the inner soft substance has wholly the structure of the Palm-stem, its vascular bundles running in the same way from the periphery to the centre, and from this to the leaf. The most external of these bundles are smaller, poor in vessels, and closely crowded, the inner consist of several rows of dotted liber-tubes, a bundle of proper vessels, and a woody portion, which differs from that of the Palms only in so far that its large vessels are not isolated, but united with the smaller vessels into the form of a crescent. Tracing these vascular bundles downwards, we see them enter the outer firm layer of the stem; instead, however, of running down the stem in the form of fine fibres into a laxer cellular tissue, as in the Palms, they retain a considerable diameter, notwithstanding that they lose their woody portion, since the prosenchymatous cells of which they are composed are very wide. They contain a small bundle of proper vessels in the centre. Under this form they run downward in the stem, as in the Palms, but are not isolated, for they unite together laterally into a network, like the ligneous bundles of the Dicotyledons. The parenchyma in which they are imbedded consists of tolerably thick-walled, porous cells, elongated in the radial direction. This outer firm layer therefore corresponds to the fibrous layer of the Palms. No trace of it occurs at the apex of the stem, since it is composed of the lower extremities of vascular bundles: the lower down in the stem we examine, the thicker this layer appears, and thus the stem is conical and not cylindrical. The younger layers of the evascular fibrous bundles are applied upon the outer side of the older, and

hence injured places upon the stem, over which no new layers are deposited, are gradually converted into depressions. On account of this continuous deposition of new layers, the assertion made by Dupetit-Thouars (*premier Essai*) and received into all botanical works, that the stem of *Dracæna* does not increase in thickness so long as it remains without branches, is incorrect, and it is easy to convince one's self of this by the comparison of young and old specimens; thus, I found that the stem of a *Dracæna Draco*, two feet high, was only about one inch thick, while trunks twenty to thirty feet high had attained a thickness of from four to six feet, although devoid of branches.

Aloë has exactly the same structure as *Dracæna*, only the outer firm layer is very thin in proportion to the soft centre. Thus, in a stem of *Aloë glauca* two inches thick, it was only two lines; while in a stem of *Dracæna Draco*, two inches thick, it had already reached a thickness of six lines. The vascular bundles of *Aloë* resemble those of the Palms still less, for the vessels are scattered irregularly in the woody portion; however, the anterior always have the form of reticulated, and the posterior of spiral vessels.

Comparing the stem of other Monocotyledons with that of the Palms, in reference to the course and organization of the vascular bundles, we find in all (excepting the very lowest forms), if not so great a similarity as in *Dracæna*, yet a great analogy. It is, namely, common to all Monocotyledons for the small evascular bundles to lie at the periphery of the stem, while those lying further in contain a bundle of proper vessels, to which succeed bundles possessing large and small vessels, while the fully developed lie toward the centre of the stem.

These bundles exhibit more or less deviation from those of the Palms, in reference to their intimate structure; but that they are all formed after one and the same type is unmistakeable. In general, the liber-layer is developed in a much less degree than in the Palms; for in many only the outer small bundles exhibit an investment of thick-walled prosenchymatous cells, while

the inner possess but a few thin-walled, wide liber-cells, scarcely to be distinguished from the parenchyma-cells and proper vessels in the transverse section, e. g. in *Asparagus officinalis, Lilium bulbiferum, Orchis militaris*, and *Sagittaria sagittifolia*. When the inner bundles do possess thick-walled liber-cells, these exist but in small quantity, and form only a narrow crescent. Sometimes their diameter is so great in proportion to their thin walls, that these cells are only to be recognised as the organ so greatly developed in the Palms, by their position and their greater development in the outer bundles; for example, in *Musa paradisiaca, Hemerocallis flava, Tulipa gesneriana, Fritillaria imperialis, Ruscus Hypophyllum, Iris sibirica, Epidendron elongatum, Aloë Commelini*, and *Scirpus lacustris*.

The proper vessels occur throughout the whole series of Monocotyledons, and lie in the same position between the liber and wood as in the Palms; they also possess the same structure, and contain the same opaque sap. In many plants they are more developed in reference to number and size than in the Palms; e. g. in *Asparagus officinalis*, where single ones, lying toward the inner side of the bundle, exhibit uncommonly large cavities. In *Musa paradisiaca*, the proper vessels, with their thin investment of liber-cells, form a large bundle, lying separate, in part, from the woody bundle, and not much inferior to it in size. In *Dioscorea villosa* also, and *Tamus*, some of the vessels lying toward the interior are developed to an unusual size. In *Sagittaria sagittifolia* the proper vessels form about half of the entire vascular bundle, and are difficult to discriminate from the surrounding cells, since these likewise have very thin walls.

The woody portion consists, as in the Palms, of more or less elongated parenchymatous cells; its vessels may also be divided into large and small; but the large are not so much separated from the small in their position in most Monocotyledons, for all the vessels generally lie together. A resemblance to the vascular bundle of the Palms does, however, occur here in so far that the large vessels lie in front and at the two sides, and the smaller behind and between the former, so that the total mass of vessels forms a more or less regular crescent, with its concavity outward, as for instance in *Asparagus officinalis, Convallaria Polygonatum*, and *Lilium bulbiferum*. In all these cases the large vessels lying at the two extremities of the crescent are reticulated tubes, while the smaller, lying further back, have the form of scalariform ducts, and the smallest, most posterior, that of spiral or annular vessels. *Ruscus Hypophyllum* makes an exception to this arrangement, as the largest vessels here lie behind and toward the interior. One consequence of this crescentic position of the vessels is, that the bundle of proper vessels retreats back between the horns of the crescent, and thus is half inclosed by the wood; e. g. in *Asparagus, Convallaria Polygonatum*, and *Lilium bulbiferum*. This is the case in the highest degree in *Tamus* and *Dioscorea*, where the proper vessels are retracted so much between the

crescent formed by the vessels, that the large vessels come in contact again in front of the bundle of proper vessels.

The unusual form of these vascular bundles may be an apology for my entering somewhat more minutely into their structure. The vascular bundles of these plants lie in two circles alternating with each other, those of the inner being considerably larger. Each of these vascular bundles is composed of a combination of three vascular bundles: one, the largest of them, situated internally, consists of a crescent of vessels, the most anterior and largest of which are finely dotted reticulated vessels, while only the most posterior and smallest have the form of spiral vessels. The proper vessels belong to this bundle. In front of this occur two vessels of tolerable size, which in many cases are likewise connected by a number of smaller vessels into a crescent, the convexity of which is directed outwards. Behind these vessels lies a second bundle of proper vessels. It is therefore evident that each of these vascular bundles is formed by the blending of two vascular bundles. The structure of the vascular bundles of the outer circle, and of those formed in the slenderest shoots of *Tamus Elephantipes*, show clearly that the outer and smaller of these vascular bundles is also composed of two bundles; for in the vascular bundles of the outer circle, the crescent formed by the vessels of the larger bundle, looking inward, is more widely open, and the anterior vascular bundles separate into two, each of which possesses a bundle of proper vessels at its inner side. In the young shoots of *Tamus Elephantipes*, the structure approaches still nearer to that usual in the Monocotyledons, for the smaller bundle is either altogether wanting, or, if present, is likewise divided into two portions, which, however, do not converge toward the large vessels, as in the stem, but have their bundle of proper vessels lying at their inner side.

In the forms enumerated hitherto, the analogy of the vascular bundle with that of the Palms is so evident as to require no further demonstration in that respect. The forms in which the different vessels exhibit almost equal diameter—e. g. in *Hemerocallis flava, Tulipa gesneriana, Fritillaria imperialis, Orchis militaris, Iris sibirica,* and *Aloë Commelini*, are rather more removed; but here also the most anterior vessels are constantly reticulated, the posterior annular and spiral vessels.

It may not be superfluous to mention a structure which may readily give rise to errors. In the vascular bundles of many aquatic plants an air-passage occurs, possessing no proper walls; for example, in *Alisma Plantago, Sagittaria sagittifolia, Scirpus lacustris, Cyperus Papyrus,* &c. If merely a transverse section of these vessels be examined, this canal may easily be taken for a vessel, as happened with Bernhardi (über Pflanzengefässe, p. 16, in *Alisma*), and Meyen (Phytot. pl. vi, fig. 1, in *Scirpus*). The whole form of the vascular bundle becomes altered through this canal. In *Scirpus* and *Cyperus* this is not so much the case, the vascular bundle being in general

very similar to that of the Grasses; but in *Sagittaria*, in which exist many vessels of tolerably equal size, these accommodate their position to the air-canal, and form a crescent, convex to the outer side, enveloped by a large bundle of proper vessels. This is the case also in *Alisma Plantago;* only a portion of the vessels are also scattered irregularly in the woody portion. I did not find proper vessels in the vascular bundles of this plant, but the liber-tubes immediately adjoined the wood.

As I have already observed, the large vessels of the Monocotyledons, as a general rule, exhibit the form of reticulated vessels; but that this does not hold without any exception, is shown by the masterly researches of Moldenhawer, on the vascular structure of the Grasses. In these, however, the vessels are still reticulated in the greater portion of their course; in others, they exhibit the form of spiral vessels. Thus, in the petiole of *Musa paradisiaca*, a very large vessel occurs in the middle of the woody bundle, in place of which, in the middle vascular bundles of the stem, three or four vessels occur. Now this vessel, as a general rule, exhibits the form of a spiral vessel, with many parallel fibres; and only in rare cases—for instance in the lowest parts of the vagina of the leaf and in the rhizome—did I find the fibres of this vessel blended together, and this frequently merely at particular places. In the same way I found, as a rule, only spiral vessels in the stems of *Typha angustifolia, Sparganium ramosum*, and in the petiole of *Calla Æthiopica*.

I shall subjoin but a few words on the cellular tissue of the Monocotyledonous stem. It consists of large cells, mostly with thin walls, yet frequently having pores; they have intercellular passages between them, and exhibit a transition of form between the polyhedral and cylindrical. These cells become of smaller diameter towards the surface of the stem, with which is combined an increased thickness of the walls. This thickening occurs to such an extent in many Monocotyledons, at the place where the outer vascular bundles lie, that a firm ring is formed around the stem, for instance, in *Arundo Donax, Ruscus Hypophyllum, Asparagus officinalis, Convallaria Polygonatum, Lilium bulbiferum, Iris sibirica, Dioscorea villosa, Tamus Elephantipes, Sparganium ramosum, Triglochin palustre, Alisma Plantago*, &c. From their thickened walls, their smaller diameter, and elongated form, these cells resemble the liber-cells, but it would be a great mistake to compare this ring with the liber of the Dicotyledons, since:—1. There are many plants, e. g. *Fritillaria imperialis* and *Tulipa gesneriana*, in which these cells are wide and less thickened in the walls, forming a distinct transition into the parenchymatous cells. 2. This ring is not sharply defined at its inner side, but passes gradually into the parenchyma of the stem. 3. The relation to the vascular bundles and the leaves is altogether different from that of the liber-bundles of the Dicotyledons to these. 4. Many herbaceous Dicotyledons exhibit this ring and liber-

bundles together with it. From these reasons it is inadmissible, although Link (Grundlehren, p. 143; Elem. Phil. Bot. p. 140) explains this ring as liber, a view which Kieser also propounded (Phytot. p. 72). This ring is very sharply defined at its outer side, and surrounded by parenchyma which represents the bark.

I have already expressed my opinion that the proper vessels lying in the vascular bundles are not to be reckoned as belonging to the milk-vessel system, in which the so-called vital sap is contained in *Chelidonium*, *Asclepias*, *Euphorbia*, *Musa*, *Ficus*, &c. This is clear from the fact that the vital-sap vessels do not occur in the place in which these proper vessels lie in the Monocotyledons, for the former lie isolated in the interspaces of the cellular tissue, chiefly in the vicinity of the vascular bundles, in the pith and the bark. But it is best proved by the existence of many Monocotyledons, in which both these kinds of vessel are met with, independently, each in its proper place, and in these cases the two kinds of vessel conveying wholly different sap. Thus it is known, for example, from Moldenhawer's researches (Beiträge, p. 134), that milk-vessels lie in the parenchyma in the vicinity of the vascular bundles in *Musa*, the sap of which, like that of *Sambucus*, assumes a red colour, and which was also recognised as vital sap by Schultz (Natur. d. leb. Pfl. i, 537). These vessels, then, are distinguished from the proper vessels in the vascular bundles by their different situation and by the red colour of their contents, which colour is never assumed by the sap of the proper vessels. The proper vessels in the vascular bundle of *Sagittaria* are no less clearly distinguished from the milk-vessels lying scattered in the parenchyma of the peduncle and petiole, for the latter convey a milky, the former a very transparent sap. In *Alisma Plantago*, likewise, the vessels filled with milky juice are wholly detached from the vascular bundles.

Comparison of the Vascular Bundle of the Palms with that of the Dicotyledons.

In order to place in a clearer light the connexion of the organization of Palms with that of the Dicotyledons, and in order to state more accurately the grounds on which I have called the different parts of the vascular bundle of the Palms, liber and wood, a comparison of the vascular bundle of the Palms with that of the Dicotyledons becomes necessary, since in the latter alone can there exist no doubt as to the true import of its parts.

In herbaceous Dicotyledons the vascular bundles stand

in a circle, and are separated from each other by strips of parenchymatous cells varying in breadth; the vascular bundle of *Laserpitium aquilegifolium* may serve as an example. We find in this a great quantity of irregularly distributed vessels, the larger of which lie toward the outside, the smaller toward the interior; the exterior vessels are porous and scalariform ducts, the deeper-lying ones spiral vessels. The cellular tissue in which the vessels are imbedded, consists of thin-walled, elongated cells, and narrow, thick-walled cells are only met with in the outermost parts of the ligneous body. The most posterior or internal part of the vascular bundle also contains thick-walled cells. In front of the vascular bundle lies a bundle of liber-cells, which is connected by a process on each side with the wood bundle; between the wood and the liber lies a bundle of proper vessels. It is here clear that this vascular bundle has entirely the same structure as the Monocotyledonous bundle, the only distinction that occurs being, that the woody mass is gradually increased in size by the deposition of new layers on its outside. The relations of the vascular bundle to the surrounding parenchyma are likewise identical with those which are found in the Monocotyledons furnished with an outer ring of thick-walled cells. The large thin-walled parenchymatous cells of the stem, which send broad processes corresponding to the medullary rays, between the vascular bundles to the bark or rind, acquire thicker walls between the anterior portions of the vascular bundle, and approach pretty closely in form to the liber-cells.

If we examine the young shoot of *Aristolochia Sipho*, we find here also a great similarity of the vascular bundles to those of the Dicotyledons,* the woody mass consisting of a thin-walled parenchyma, the cells of which do not lie in any definite order. In the back part of the vascular bundle are found minute spiral vessels; in front, large porous vessels. It is only in front of these large

* Qy. misprint for Monocotyledons.—TRANS.

vessels, after the woody mass has increased in size by further growth, that the wood-cells begin to arrange themselves in regular rows. In front of the wood lies a large bundle of proper vessels, which may be readily distinguished from the parenchyma by their thin walls, and the absence of chlorophyll-granules. This vascular bundle is distinguished from that of the Monocotyledons, by the fact that the liber does not stand in immediate connexion with the vascular bundles; but the liber-bundles grow together in waving lines, and are separated from the proper vessels by several layers of cells. We find the same structure in the vascular bundle of *Menispermum canadense*.

Comparing the vascular bundle of the Monocotyledons with that of the Dicotyledonous trees, we meet with a great resemblance, the posterior portions of the wood having the cells thin-walled, and placed in no regular order. The smallest vessels lie farthest back, and are spiral; nearer to the front lie larger scalariform ducts, and to these follow the large porous vessels. We do not come to the firmer portion of the wood until we arrive at the front of these, this wood being composed of thick-walled cells lying in regular rows, and of porous vessels.

From these facts it is most clear:

1. That the vascular bundle of the Monocotyledons exhibits the same composition, as that of the Dicotyledons possesses in its earliest condition.

2. That the part of the vascular bundle of the Palms, which I, in spite of its having no ligneous solidity, have denominated the wood, corresponds most closely with the innermost part of the ligneous body of the Dicotyledons, to which Hill applied the name of the *Corona*.

3. That in many Dicotyledons, also, a bundle of proper vessels lies between the liber and wood; besides the plants named, this may be found in *Spiræa Ulmaria*, *Aruncus*, *Fumaria officinalis*, *Echinops*, and *Mimosa pudica*.

4. That the portion composed of prosenchymatous cells,

lying in front of this bundle of proper vessels in the Monocotyledons, is not to be referred to the wood, but to be considered as the liber of these plants.

On the other hand must be mentioned, as distinctions in these structures:

1. That in the Dicotyledons, the formation of the vascular bundle is not concluded with the development of the *Corona*, as in the Monocotyledons.

2. That in very few Dicotyledons is there a bundle of proper vessels between the liber and wood.

3. That in most Dicotyledons the liber-bundle is separated from the wood-bundle by some layers of cells; that it does not exhibit such different degrees of development in different parts of the bundle; and that it never attains to such considerable firmness and size, as in many Monocotyledons.

It has already been observed that, besides the proper vessels, milk-vessels are met with in many Monocotyledons; the same occurs in many Dicotyledons; for instance, in the Umbelliferæ, where milk-vessels lie among the proper vessels in the wood-bundle, as well as in the pith and rind, while the milk-vessels of the Dicotyledons, e. g. in *Euphorbia*, *Asclepias*, *Morus*, *Acer*, *Sambucus*, &c., scarcely ever occur in the vascular bundles, but only in their vicinity, in the bark and pith. (See Bernhardi, über Pflanzengefässe, p. 53; Treviranus, Beiträge, p. 44; Moldenhawer, p. 126.)

Comparison of the Palm-stem with the Stem of Dicotyledons.

So long as Desfontaines' theory, that the young vascular bundles of the Palm-stem originate in the centre, is believed to be correct, no parallel can be drawn between the stem of Palms and of Dicotyledons, for in such a condition these stems would exhibit only distinctions, but no resemblances. Since, however, the course of the vascular bundle is quite different from what was formerly supposed, and since its structure agrees perfectly with that of the vascular bundle of the Dicotyledons, it appears to

me that a comparison between the stems of the two great classes of vegetables may be instituted without straining the facts.

Although the vascular bundle belonging to each individual leaf cannot be distinguished from the rest in the cross section of a Palm-stem—since the position in concentric circles (which should result from the similar course taken by all the vascular bundles going to one leaf) is variously distorted—yet we may imagine the vascular bundles going to each leaf united into a tubular layer. This tube, however, is not cylindrical, but forms an elongated cone. As long as the leaf which is supplied by these bundles remains the uppermost, the conical tube, composed of its vascular bundles, forms the most external layer of the stem. But when a new, higher leaf is developed, the vascular bundles going to this leaf form a new layer, which is developed on the outside of the last layer. Since, however, the apices of these conical layers are not closed, but the vascular bundles of which they are composed run outward again from the centre of the stem to reach the leaves, the above described crossing results, occurring between the vascular bundles which emerge into a leaf, and all subsequent bundles running up to younger leaves.

If we compare with this the structure of the first year's shoot of a Dicotyledonous tree, for excellent observations on which we are indebted to Dupetit-Thouars (Histoire d'un morceau de bois), we meet with a very similar course of the vascular bundles. The vascular bundles in it, running to the lowest leaves, which have formed the *corona* on the lowest part of the branch, and which we will designate A, pass in a curve outwards, and the vascular bundles supplying the next succeeding leaf above (B), lie with their lower portions on the outside of the bundles A, up to the point where these latter turn outward; above this they form the succeeding portion of the *corona* up to where they also pass outward into the leaf. We see, therefore, that the course of the vascular bundles

in the Palm-stem and in the one-year old shoot of the Dicotyledons is exactly similar, and that the conception of a different mode of growth, and the division of plants into Endogens and Exogens formed on it, is altogether opposed to nature.

I have always found the structure of the yearling shoot of the Dicotyledons, such as I have described; I cannot, therefore, agree with the description given by Schweigger (Beobacht. auf naturhist. Reisen, 107), which goes to show that in the Dicotyledons the upper leaves are supplied by the internal, the lower by the external vascular bundles.

In spite of this resemblance, we must not overlook the fact, that very important differences occur in the organization and growth of Dicotyledons and Monocotyledons. In the yearling stems of a Dicotyledon, the vascular bundles going to the higher leaves are interpolated in their lower part, between the liber and wood of the older. The wood of the younger thus becomes blended with that of the older, while in many cases the liber-bundles of these remain isolated. From this cause, the wood in the lower part of the stem becomes thicker, and the entire stem acquires a conical form. In the Palms, on the contrary, in the vascular bundles of which the liber and wood stand in the closest connexion, the lower parts of the younger bundles are never interposed between the wood and liber of the old, but lie isolated in the cellular tissue of the stem, nearer to the periphery than the older bundles. Thus neither the liber nor wood of the older bundles exhibit a deposition of new portions, but remain permanently in that stage of development, which they have attained at their original completion.

We must not consider it as an universal distinction, that in the Monocotyledons the vascular bundles do not unite laterally into a reticulation, since, on the one side, in *Dracæna*, *Aletris*, &c., the fibrous bundles of the outermost layers become connected together in this way, and on the other hand, in some of the herbaceous, and even in many woody Dicotyledons, for instance, in *Rosa* and *Rubus*, this lateral connexion of the vascular bundles does not exist.

The phenomenon that the Palm-stem grows but little

in thickness, which at the first glance seems to indicate a great difference of its growth from that of the Dicotyledons, is readily accounted for by the smaller size of the lower part of its vascular bundles. That it does not increase in thickness at all is not a perfectly correct statement, for it certainly does exhibit a slight enlargement by growth; this increase of diameter occurs in many Palms, for example, in *Areca oleracea* and *Iriartea ventricosa*, not so much at the inferior extremity as higher up in the stem, whence this acquires a spindle-like form. Since the lower part of the bundles is not thicker than a hair, it will be conceivable how many thousands of them may be formed beneath the rind of the stem, without increasing its diameter more than a single inch, which is so slight a growth that it is wholly overlooked.

I have already stated that the fibrous bundles in *Dracæna* become more strongly developed, and that the stem then grows in thickness as in the Dicotyledons. From the circumstance that these bundles, lying in the external layers of *Dracæna*, are nothing else but lower extremities of the vascular bundles of the stem, it is most evident that their growth and development is not to be regarded as anything different from the growth of the apex and the centre; and that the idea of a double growth, which Mirbel (Annal. du Muséum, xiii, 67) imagined that he found in *Dracæna*, *Yucca*, *Aloë*, *Ruscus*, *Smilax*, *Dioscorea*, and *Tamus*, is no less incorrect than the idea of the central vegetation generally attributed to the Monocotyledons.

Obs. 1. I have mentioned above that Moldenhawer had already expressed himself against the correctness of the view of Desfontaines. Moldenhawer distinguished in the same way, as has been done above, in every vascular bundle of *Zea Mays* and *Bambusa*, in which plants his investigations were chiefly made, liber, proper vessels, and wood; he also found that, in the Grasses and Palms, the younger leaves were supplied by the outer, the older by the inner vascular bundles. (Beiträge, p. 50.)

Thus far, therefore, our researches fully accord; but they differ in many points in respect to the fibrous bundles devoid of vessels, and the origin of the wood, the reason of which doubtless lies in the fact, that Moldenhawer

neglected to examine the same vascular bundle in various parts of its course, so that its changes of form and structure remained unknown to him. Moldenhawer states that both in the Grasses and the Palms, fibrous bundles without vessels are formed beneath the rind, and believed that shortly after their formation proper vessels, and subsequently the wood portion, were deposited on their inner side, and that in this way the fibrous bundles became vascular bundles. I cannot confirm this account, for the transition from the evascular fibrous bundle into the vascular bundle is merely one relating to space, and has no reference to its development in time; the lower part of every vascular bundle remains permanently in the condition of an evascular bundle of prosenchymatous cells, while its upper portion does not appear, even in its earliest stage, in the form of a liber-bundle; but even at a period when it is still of a gelatinous delicacy of consistence, the rudiments of all the parts which it subsequently contains may be detected in it.

Moldenhawer further states, that in the Palms, not only has each vascular bundle its proper liber, but there exists besides a general liber, lying under the rind (l. c. p. 56). There is found, he says, in *Phœnix* and other Palms, a line of separation between the wood-layer and the rind, from which those fibrous bundles develope inwards, which are changed into vascular bundles, but on its outside, those which contain only fibrous cells, the latter being comparable to the liber of trees. A correctly observed fact certainly appears to afford the ground for this opinion. I have observed already, that in many Palms, especially in the *Cocos*-like stems, the rind becomes gradually thickened, and this in an irregular manner; that larger or smaller portions of the cellular tissue in which the fibrous bundles are imbedded acquire thickness in their walls, and form a firm, apparently dead envelope. In this change of the outer parts of the fibrous layer, the newly-developing fibres cannot be produced on the outside of the older; they must, therefore, originate in the interior of the fibrous layer, and the matter may thus acquire some resemblance to the formation of liber in the Dicotyledons. But a second circumstance also has to be considered, which might have contributed still more readily to render Moldenhawer's opinion, that the Palms possess a general liber, plausible. In those species, namely, where, as in *Cocos,* the outer fibrous layer is very thick, in tracing their evascular fibrous bundles, it is found that they do not all enter into the interior of the stem, and become converted into vascular bundles, but that a portion of them pass immediately into the petiole. But as those fibrous bundles are changed, like the rest, into vascular bundles in the petiole, they cannot be regarded as liber-bundles corresponding to the liber of the Dicotyledons.

2. Another circumstance remains to be mentioned, occurring in many Palms, and which at first sight does not appear to harmonize with the theories of their growth detailed above. We find in many Palms, that their evascular, small, fibrous bundles do not all lie between the rind and the developed

vascular bundles, but some of them are met with scattered among the vascular bundles of the stem, for example, in *Astrocaryum vulgare*, *Cocos botryophora*, *coronata*, *Leopoldinia pulchra*. I have met with this modification principally in the *Cocos*-like stems, in others only in rare cases. These fibres, therefore, only occur in such stems as possess a fibrous layer abundantly furnished with fibres, and a great many vascular bundles. Consequently it is probable, that in the great mass of closely-crowded bundles which fill up these stems, circumstances readily arise, which prevent the nascent fibres from becoming developed in the normal positions, and give rise to their origin in unusual places. These scattered fibres, too, do not seem to occur in all specimens of the same species, at least they were very abundant in one stem of *Leopoldinia pulchra*, while in a second they were altogether wanting, which evidently proves that accidental causes give occasion to their origin.

3. Mirbel fell into still greater error than Moldenhawer in his researches into the course of development of the vascular bundles of the Monocotyledons. He states (Annal. du Muséum, xiii, 69) that each vascular bundle is formed, at its origin, solely of one bundle of large ducts (reticulated vessels), that around these a tissue of delicate tubes is gradually formed, by which is understood the cellular tissue of the wood, the spiral vessels, annular vessels, the proper vessels, and the liber-bundle, these parts not being distinguished. The membrane of these tubes, then, gradually becomes so much thickened that at length their cavities are filled up.

4. In a description of the vascular bundle of *Calamus* (Ann. d. Sc. nat. ii, pp. 229-236), Amici attributes a different import to the different parts of the vascular bundle from that which I have done. Amici considers the wood-cells to be liber-tubes, the liber-tubes proper vessels, the proper vessels he indeed recognises as thin-walled and not porous tubes, but leaves it undetermined to what kind of organ they belong. The description and representation of the vascular bundles of *Calamus*, given by Kieser (Phytot. p. 121, Tab. iii, fig. 29), deviates still more from the truth, since the liber- and wood-layers are not distinguished at all, and the proper vessels are regarded as spiral vessels.

5. I shall readily be excused from detailing minutely the views of Lestiboudois; he believes that the Palm-stem is to be compared with the bark of the Dicotyledons, he finds nothing analogous to wood and pith. (Principes de Botanique, pp. 149-158.) This strikingly testifies how little he is acquainted with the minute anatomy of plants.

OF THE ROOT OF THE PALMS.

Form of the Root.

The full-grown Palm-stem is never furnished with a tap-root, but its inferior portion, rounded off like a bulb, is clothed with a quantity of fibrous, branching roots. These roots are always slender, not very long, beset in an irregular manner with slender lateral branches, cylindrical, obtuse at the extremities, in the young condition white, and subsequently brownish. Their young shoots are clothed with fine hairs; sometimes short spinous elevations occur on the root, which are to be regarded as abortive lateral branches. The germinating Palm has a tap-root, but this attains no considerable size. Shortly after germination, side roots are developed from the base of the stem; the tap-root disappears, and after a time the first side roots also die away, and are replaced by new rootlets, which spring out in a circle above the earlier ones. This process is repeated in a manner analogous to that in the bulbous plants. Although the roots arise very closely crowded together, yet the subterraneous portion of the stem soon becomes completely covered with roots, and the new ones then arise, as in *Pandanus*, above ground. In this way it often happens that the stem stands raised free above the surface of the earth, merely supported by the roots; for example, in *Iriartea exorhiza*.

The formation and first development of the roots occur in the interior of the stem, between the fibrous layer and the developed vascular bundles. In this place is formed a nucleus of cellular tissue (a true bud), which acquires the shape of a root, and breaks through the rind. Such buds of future roots may be found in considerable abun-

dance for the distance of some inches above the youngest circle of roots, when the bark and fibrous layer are cut open down to the vascular bundles.

Anatomical Examination of the Root.

The Palm-root is composed of two distinctly separated layers—an outer, looser, and spongy cortical substance, and a tough, woody, central bundle.

The cortical substance is coated by a parchment-like membrane, under which lies a white spongy mass, in which in some species lie liberous fibres; in others these are wholly wanting. Toward the extremity of the root, and in the young side roots, this cortical layer is succulent and compact; in the older parts of the root it is often half dried and more lax. The central bundle is formed of a compact woody substance, which cannot be separated into distinct individual bundles like the wood of the stem. The central bundle of the side roots is immediately connected with that of the main roots.

When a root is traced backwards into the stem, it is found that the cortical part of the root is considerably diminished at its entrance into the cortical layer of the stem, after a short distance disappearing by blending with the cellular tissue of the stem. The central bundle, on the contrary, penetrates the fibrous layer of the stem, and spreads out on the outer layers of the wood-bundles of the latter in the form of a disk. In its way through the fibrous layer, it already begins to divide into several bundles, separated by thin layers of cellular tissue. When it arrives at the woody layer of the stem, it divides into a great number of delicate filamentous bundles, which run out in all directions like the rays of a star, and, passing in serpentine course between the vascular bundles of the stem, enter into its interior. They cannot be traced more than about half an inch down between the woody bundles, because they continually divide into

successively finer portions, apply themselves upon the vascular bundles of the stem, and there terminate.

Besides this connexion with the interior of the stem, the root is most intimately connected with fibrous layer by means of its cortical portion; for, into the cortical portion of each root penetrates a portion of the evascular fibrous bundles of the stem. In some roots, as in those of *Cocos* and *Phœnix*, the little fibrous bundles run still further out into the roots, and then lose themselves gradually; in others, as in *Diplothemium maritimum*, *Sabal Adansonii*, they are at once lost at the very beginning of the root.

In *Dracæna Draco*, also, I observed that the outer, fibrous, firm layer of the stem penetrated the roots, was continued some distance in this, and formed a sheath round its central body, which was far stronger and longer on the side turned towards the surface of the earth than on the under. This fibrous layer was gradually attenuated, and altogether lost in the distance of a few inches. It is clear from this, that the opinion of Dupetit-Thouars, that the roots are formed of the fibres running down from the leaves and buds, is totally erroneous.

The roots of different Palms possess a very similar organization. That of *Diplothemium maritimum* may serve as an example. In the cross section, it is seen that in the central bundle all the vessels lie toward the circumference, and the middle is formed solely of cells. The vessels are constantly placed in such a manner that the largest are nearest the centre, the smallest nearest the circumference; therefore the condition is the contrary of that which we have met with in the stem. The vessels do not lie, as in the vascular bundles of the stem, irregularly scattered and isolated, but in rows, which are directed from the centre toward the circumference, and these rows are frequently split toward the exterior into two diverging arms. The largest of these vessels present the form of reticulated vessels, and are composed of rather short tubes, possessing reticularly perforated septa at their ends. The small vessels, situated more externally, exhibit the form of porous and scalariform ducts. In

respect to the epoch of their development, the latter agree with the spiral vessels of the vascular bundle of the stem, for they are already completely formed at a time when the large vessels still appear as thin-walled tubes without fibrous deposits, and the cells of the root have yet but extremely delicate membranes. The vessels are surrounded by rather thick-walled, much elongated cells, with horizontal septa. But only those cells situated next to the vessels exhibit these horizontal septa, and they pass, in the interspaces between the vessels and in the central space inclosed by the vessels, into prosenchymatous cells, which, in the centre of the vascular bundle, are again transformed into elongated parenchyma, and form an analogue to the pith. The whole central body is surrounded at its circumference by a few layers of thin-walled prosenchymatous cells, to which follows a row of narrow, elongated thick-walled cells.

Between every two groups of vessels lies a bundle of proper vessels; the size of this is ruled by the length of the rows of vessels lying beside it, for only a small roundish bundle lies between the short rows, while those situated between the long rows extend far in toward the centre of the root. The arrangement of the proper vessels is always such, that those lying internally are very wide, the outer very narrow: the narrower and wider are not, as in the stem, mingled together. The membranes of these vessels are always thin, not unfrequently finely porous, which also sometimes occurs in those of the stem of *Tamus elephantipes*. They are composed, both the wide and narrow, of closed elongated tubes, with horizontal or diagonal septa; like those of the stem, they contain an opaque, granular sap.

The cortical substance consists chiefly of regular thin-walled parenchyma-cells, with intercellular passages. Those cells in the vicinity of the vascular bundle have no intercellular passages between them, and are somewhat expanded in the direction of their breadth. The intercellular passages also disappear toward the surface of the

rind; the cells become larger; the outer, at the same time, acquire thickness in their walls, and form the coriaceous membrane above described. The epidermis is composed of cells not elongated, but papilliform and projecting. In the young root the rind is compact; but with the greater expansion of the root in thickness, and the decrease of its juices, the cells separate from each other in isolated, larger or smaller, irregularly scattered places, and thus form irregularly distributed air-cavities. The cells immediately surrounding the central body, contain on their inner side transverse fibrous thickenings, like many anther-cells. Isolated cells, scattered without order in the rind, contain raphides.

The lateral roots spring from the larger roots in the same way as these do from the stem. A nucleus of cellular tissue is formed between the rind and central body of the main root, and in this are developed moniliform vessels. On further enlargement, this nucleus breaks through the rind of the root, and appears as a branch of it. The moniliform vessels penetrate the central body of the root, run in the most varied directions in the cellular tissue situated between the vessels, and finally apply themselves to the sides of the large vessels. In the lateral root itself, the vascular tubes become more and more elongated, and form, with a portion of the cellular tissue which they inclose, and with the elongated cells by which they are surrounded, the central body of the root-branch. The most external layer of these elongated cells is blended with the thick-walled cells surrounding the central body of the main root; while the more central, pith-like cells of the lateral root are connected with the parenchyma situated beneath these elongated cells. The rind of the side root is, indeed, separated from these in the greater part of its course through the rind of the main root, by its epidermis and its outer layer of elongated cells; but both the elongated and the parenchymatous cells of the rind of the side root are blended with the more internal layers of the rind of the main root.

The connexion of the root with the stem takes place in a manner wholly analogous; since in this also, in the dissolution of the central body into single fibres, its vessels are distributed into a great number of fine moniliform vessels. Those fibres penetrating the stem are, indeed, formed for the most part of thin moniliform vessels; but they nevertheless present an organization tolerably resembling that of the vascular bundle of the stem, for their vessels are surrounded by cellular tissue, a little liber-bundle lies upon their outer side, and their proper vessels occur between this liber-bundle and the wood.

I found the structure described, perfectly similar in the roots of a considerable number of Palms, as might indeed be expected, since the said structure occurs almost as universally in the roots of Monocotyledons as the above-described structure of the vascular bundles in their stems.

This structure, however, is not without exceptions. I have already said that in the upper parts of many Palm-roots, e. g. *Phœnix*, *Cocos*, fibrous bundles are scattered through the rind, while no trace of them is found in others. But the rather thick root of *Iriartea exorhiza* exhibits more important deviations. A cross section of it presents to the naked eye a star composed of brown lines, with obtuse, mostly bifid, rays. The microscope shows that this star is formed of crowded vascular bundles. Besides these, scattered vascular bundles occur singly in the centre of the star, but a central cord, like that in the other Palm-roots, is wanting. The vascular bundles have a structure totally unlike that of the vascular bundles of the stem, the relative position of their organic systems being quite different. The liber-bundle is directed towards the centre of the root, and in some of the vascular bundles lying in the middle of the root, surrounds the woody portion. The liber-tubes have thicker walls, and are more numerous in the outer bundles than in those situated in the middle. The woody portion has 1, in rare cases 2-3 large vessels, which in the outer bundles are $\frac{1}{25}$-$\frac{1}{17}$, in the inner, $\frac{1}{17}$-$\frac{1}{13}$ of a line in diameter. They are composed of longish tubes, some have horizontal septa, some are without these; their walls are covered with little pores, placed in longitudinal rows; where two vessels are in contact, they have the form of scalariform ducts. They are surrounded merely by 1-2 rows of parenchymatous cells. The outer side of this woody portion is in contact with the parenchyma of the root. The bundles of proper vessels, of which each vascular bundle contains one or two groups, consist, as in the stem, of mingled, wide and narrow tubes. These do not lie between the wood and liber, but in most cases on the outside of the liber-layer, half

imbedded in it; in the inner vascular bundles, the proper vessels are sometimes wholly surrounded by the liber-tubes. The outer vascular bundles are often confluent in pairs, in which case the compound bundle possesses four groups of proper vessels, or, from the confluence of one pair, frequently only three.

The parenchyma of the root consists of thin-walled, somewhat elongated, porous, parenchymatous cells, which in many places leave irregular spaces between them. Around the stars formed by the vascular bundles, separated from them by a few rows of cells, runs a darkish line, formed by cells with rather thicker walls. Scattered through the whole root, and accumulated in especial quantity in its outer layers, lie evascular, fibrous bundles, the outer of which are often blended together, and are composed of thick-walled, prosenchymatous cells; in the middle of those situated more internally, occur from one to two thin-walled cells, which probably belong to the system of proper vessels. I can state nothing concerning the connexion of these fibrous bundles with the stem, as I had no opportunity of examining the latter. These roots of *Iriartea* are clothed with short thorns, which are to be looked upon as abortive lateral branches, and have their origin from the vascular bundles of the main roots.

Different as this root appears to be from those of other Palms, yet it is clear that its organization agrees with that of the latter in many respects, since most of the characters by which the vascular bundles of the roots are distinguished from those of the stem, occur in the root of *Iriartea*, as well as in the roots of other Palms. The reversed position, which is exhibited by the vascular bundles of the roots of *Iriartea*, corresponds to the circumstance met with in other Palm-roots, that the cells lying behind their vessels likewise have the form of prosenchymatous cells. In both varieties of the root the large vessels lie furthest inward, the small ones externally; in both, the proper vessels form special bundles not inclosed between the wood and liber.

APPENDIX.

It will not be unfitting to append to the preceding description of the Palm-stem, a short account of the works on this subject, which have appeared since it was first published.*

* My purpose here is not an enumeration of all the observations on this subject which have appeared since my Anatomy of Palms, but only an

Pre-eminently deserving of mention is the acute Essay of Meneghini (*Ricerche sulla Struttura del Caule nelle Piante Monocotiledoni*, Padova, 1836), in which the structure of the stem of Monocotyledons is traced in its various forms, and described with great clearness. So far as this exposition relates to the arborescent Monocotyledons, the following points might indeed be brought forward in opposition to my description. Meneghini, who, in his description of the course of the vascular bundle, traces it as I did from above downwards, devotes especial attention to the changes which its position undergoes during the development of the terminal bud into stem, and, in reference to this, lays particular stress upon the circumstance that, so long as the leaves remain inclosed in the bud, only that part of the vascular bundle exists, which in the full-grown bundle runs from the middle of the stem downwards and outwards, and that its upper portion is first developed with the development of the bud into stem, and with the emergence of the leaves from the centre of the bud out to the lateral surface of the stem. From this passage outward of the leaf from the centre of the bud, is derived the curve of the vascular bundle in the centre of the stem, and the outward direction of the course of the upper part of the vascular bundle. Meneghini paid especial attention to the examination of the circumstance that the vascular bundles present, not only this curve outward, but at the same time a lateral bend, so that their lower extremity does not lie in a perpendicular direction beneath the upper end, but diverges to its left or right. I also had observed this circumstance in the Palm-stems I investigated, but attached no importance to it, as I considered the oblique course of the fibres an accidental deviation.

examination of such works as have had an influence on the progress of the study of the structure of the stem of Monocotyledons, and especially of the Palms, whether by the announcement of new, hitherto unnoticed facts, or by the extension of the study in its theoretical aspect; I therefore shall pass over, in particular, Gaudichaud's works, since the researches on which his theory rests, have too much the stamp of superficiality to allow me to expect any profit from them to the study of the structure of plants.

Meneghini has shown, on the contrary, that this condition occurs in all Monocotyledons; for the elucidation of this he did not select Palms, but principally the stems of *Dracæna*, *Aletris*, and *Yucca*, in which, however, if his theory be correct, the oblique course of the fibres deviates materially from that occurring in the Palms. In order to give a review of the opinion promulgated by Meneghini, an examination of his investigation of *Dracæna* and the allied forms is necessary. Meneghini states, in regard to *Dracæna Draco*, that no fibre of its stem runs vertically, but that the upper part proceeds inward in the direction of a radius, toward the centre of the stem; near this it turns downwards, and at the same time to the right or left, and then runs obliquely downwards and outwards, so that its inferior extremity lies beneath the surface of the stem, to the right or to the left of the upper end. Perhaps no two vascular bundles of the same leaf exhibit the same course, for some penetrate almost to the centre of the stem before they turn downwards, others acquire a curve at a short distance from the rind, some deviating to the right, others to the left of the perpendicular line.

The changes which the leaf undergoes during its development are regarded as the cause of this oblique course of the fibres. As the adoption of this point of view by Meneghini is wholly peculiar, and forms the most essential part of his doctrine of the structure of the Monocotyledonous stem, we must enter somewhat more minutely into it. Meneghini assumes that, in all the Monocotyledons, the leaf originates in the form of a closed, reversed funnel, which subsequently becomes torn up along one side, either the whole way or only at its upper part, by the pressure of the younger leaves succeeding it in the interior. When only the upper portion is torn, the lower part forms the sheath of the leaf, and the leaf remains perfectly amplexicaul; in the other case, the relation of the base of the leaf to the circumference of the stem does not necessarily remain the same in its further development, but the stem usually grows, proportionately, more in thickness, than the base

of the leaf in breadth, and thus the leaf occupies so much the smaller arc of the circumference of the stem, the older the latter grows; while in other cases, the converse may take place, the leaf grow broader than the stem, and the two borders of the leaf overlap. As examples of such plants, in which the originally perfectly amplexicaul leaf only partly embraces the stem when full-grown, *Aletris fragrans* and *Dracæna Draco* are, in particular, brought forward; in the former, the full-grown leaf embraces $\frac{5}{8}$ of the stem, in the latter, the leaves at the apex of the yearling-shoot are still perfectly amplexicaul, while on older stems the cicatrices of the leaves only extend $\frac{1}{3}$ round the stem. This proportionately greater expansion of the stem in thickness is connected, in *Dracæna*, with an abbreviation of the already perfectly formed internodes, as is apparent in a comparison of the length of the internodes of the yearling-shoot with those of the old stem, and as even a superficial examination of the growth of *Dracæna* shows; for the rapid growth of the yearling-shoot does not by any means correspond to a proportionate elongation of the whole plant (p. 22). A necessary consequence of this change of the relative proportion of the breadth of the leaf to the thickness of the stem is, a change of the original position of the vascular bundles in the interior of the stem. So long as the young leaf surrounds the stem and lies in the middle of the bud, the vascular bundles (corresponding to the lower portions of the complete vascular bundles) run from the whole periphery of the stem, in a radial direction, towards the base of the leaf. As the bud unfolds, the internode perfected beneath the leaf to which it belongs, and the leaf proceeds outwards from the centre of the bud towards the periphery of the stem, the upper portions of the vascular bundles are developed, which, in consequence of this outward movement of the leaf, assume a curve from the centre of the stem towards the exterior, and run out in the direction of a radius. Since, however, during the completion of the leaf, the proportion of its breadth to

the circumference of the stem diminishes, the upper part of the vascular bundles must also follow the leaf, and, therefore, those vascular bundles which enter the sides of the leaf, instead of being directed in a radial direction to all sides of the stem, as in the perfectly amplexicaul leaf, are only curved towards the arc of the circumference of the stem, on which the leaf is inserted, and since the lower part of each vascular bundle retains its position more or less unchanged, the result is the described condition of a double curvature, downwards and to the side. The greater the difference between the circumference of the stem and the breadth of the base of the leaf, the shorter the internodes, the greater must be this divergence; hence it is greater in *Dracæna* than in *Yucca*, in *Yucca* it is greater than in *Aletris*.

Before I go further into the detail of Meneghini's theory, it will be advantageous to test the facts on which it rests. In this I pass over the question whether the leaves do originate under the form of closed funnels, or not, as this has no essential influence on the theory. The only essential question is, whether or not the breadth of the base of the leaf does gradually diminish its proportion to the circumference of the stem with the age of the latter. That such a change must lead to the alteration in the course of the vascular bundle which Meneghini has deduced from it, does not admit of a doubt; at all events, if it be presupposed that at the time when this change takes place, the vascular bundles running to the younger leaves, which cross those of the leaf that has begun to change its position, do not oppose any hinderance to the movement of the latter. I believe that this certainly must be the case, and this circumstance alone already makes the theory of the Paduan phytotomist appear untenable; if, however, we even overlook this, there exist other, more definite reasons, which show that the unequal growth of the leaf and the circumference of the stem do not occur in the way Meneghini has represented. According to his statements, this process is most clearly to be seen in *Dracæna Draco*, for the leaves, or their

cicatrices, embrace a smaller portion of the circumference of the stem, in proportion as they are situated lower down upon it, so that the cicatrices only occupy a third of the lower part of the stem, while the leaves at the summit of the yearling-shoot completely surround it.

I can only confirm the smallest possible part of this statement. I decidedly found no change of the relative position and size of the cicatrices, in the stems which I examined in reference to Meneghini's statements, (the largest being about twenty-seven feet high, and thirty-seven centimeters in circumference at the lower part), but the scars of the leaves just fallen exhibited the same proportion to the circumference of the stem as the scars at the lower part of the stem, i. e. they extended round about $\frac{2}{3}$ to $\frac{3}{5}$ of the stem. Measurements, which I instituted on different cicatrices, showed that small variations occur in the proportion of the breadth of the scar to the circumference of the stem, which are not at all connected with the age of the stem. Removal of the leaves from the terminal bud showed, that not only is the same proportion of the base of the leaf to the circumference of the stem to be found in the leaves which are seated on the conical portion of the stem, concealed in the leaf-bud, but that it also holds for those leaves situated on the upper, flattened surface of the axis of the bud, excepting the innermost. As, on the other hand, continuing the removal of the leaves, we approach the youngest leaflets, this proportion alters, for the borders now certainly do approach each other. In one bud I examined, the borders of the innermost leaflet in which the lamina was distinctly formed, were approached to within $\frac{1}{6}$ of the circumference of the circle; the next leaflet appeared in the form of a perfectly amplexicaul cone, about one millimeter in diameter, at the base of which was to be seen a narrow, short slit; it had exactly the form of the cotyledon of a Monocotyledonous embryo; in the succeeding leaflet, the slit formed by the borders of the leaf was again more widely opened. This observation does indeed fully con-

firm the assumption of Meneghini, that in *Dracæna Draco* the perfectly amplexicaul leaf is changed into one which does not surround the stem, but an essential distinction exists, in that Meneghini states this change to begin after the completion of the leaf, and to be continued further in the cicatrix after the fall of the leaf; while the result of my investigation is, that the leaf only surrounds the stem so long as the part of the axis of the bud on which it is inserted is still in a rudimentary condition, and the thickness has not, or scarcely, exceeded a millimeter; that in the next older leaflet the borders are already $\frac{1}{6}$ of the circumference of the stem apart, and the permanent proportion between the base of the leaf and the circumference of the stem already exists in the leaflets situated but a couple of internodes further out. This difference in the results of our investigations is very much the more important, as will be shown further on, in so far that such an alteration of the proportion of the breadth of the base of the leaf and the circumference of the developed stem must cause extraordinarily great changes, which we never see, in the internal structure of the stem, and in its growth in thickness; while such changes, if they begin in a portion of the stem a millimeter thick, and cease in a part only a few millimeters in diameter, take place in a part which consists merely of soft cellular tissue in full process of multiplication, which exhibits extremely rapid growth in all its parts, in which, therefore, the softness and continual metamorphosis of its substance, present no mechanical hinderance to a more rapid development of one part, and a less extensive development of another. That these changes of form exert influence on the lateral divergence of the vascular bundles cannot, indeed, be denied; but, on the other hand I cannot think, that they are the sole, or even the principal cause of their oblique course, inasmuch as this occurs in the vascular bundles of *Aletris fragrans*, although no trace of an alteration of proportion between the base of the leaf and the circumference of the stem is to be discovered here.

According to Meneghini's statements, the borders of the leaves should here also separate so far, that the cicatrix only surrounds $\frac{5}{8}$ of the stem; but I cannot give the least confirmation to this statement. The borders of the leaf overlap a little at the base; this condition is no longer visible on the cicatrix after the leaf has fallen, for this appears simply encircling the stem. However, this peculiarity is exhibited not merely by the young stems, from which the leaves have newly fallen, but also by old stems; and, in particular, on a stem thirty-eight centimeters in circumference, in the Tübingen Garden, the leaf-scars are perfectly evident, and still exactly surround the stem, although, from the great increase in thickness, its rind presents many longitudinal fissures. Consequently, observation of the surface of the stem, decidedly does not confirm Meneghini's view as to the alteration of the leaf of *Aletris*, and the subsequent changes in *Dracæna;* and the matter might here have been regarded as settled, but that the objection that in other specimens than those which I have examined, the conditions might exist such as my honoured friend has described, rendered it to the purpose, to institute a more minute examination of the changes which a stem would necessarily undergo, the circumference of which became more enlarged than the bases of the leaves, in the way described, after its leaves were perfectly formed or had fallen, since this examination will show that this process cannot possibly present itself in stems with abbreviated internodes. I have before me a portion of a stem of *Aletris fragrans* 31 inches long; at the upper end it is 10·5 lines in diameter, at the lower 13 lines; the external, hard, fibrous layer is 1 line thick above, 2·5 lines thick below: there are upon it 57 leaf-scars, hence an internode is, on an average, 6·5 lines long. The cicatrices surround the stem, and are placed obliquely, in such a way, that one part of each of them, corresponding to the middle line of the leaf, is lower down than the opposite part corresponding to the borders of the leaf; so that

in each case the point of insertion of the borders of a leaf is approximated to within about three lines of the point of insertion of the central portion of the leaf next above it. If, now, we imagine the lowest internode to expand so much in breadth (without enlargement of the cicatrix), that the meeting borders of the cicatrix would be separated about $\frac{1}{5}$ of the breadth of the cicatrix, a portion of stem, nearly eight lines in breadth, must be inserted between the separating borders of the leaf; and during the period of the completion of the structure of this piece of stem, new tissue must be formed in the interior; the firm, fibrous layer, already 2·5 lines thick, must enlarge a fifth part of its circumference; and the inner soft substances must increase in quantity, in like proportion, to fill up the space within this expanded layer. Of all this, no trace can be found in the examination of a stem of *Aletris*. Instead of what this theory requires, the insertion of an entire segment of a circle between the old parts, and the enlargement of the internal soft substance, we find that the latter, when once formed, remains for ever unchanged, and in like manner no new development is met with, in any part of the substance, of firm woody layers; but we do find that new fibres and cells are produced uniformly in a true cambium layer around it, and upon its outside. This stationary condition of the internal parts of the stem, is again, fully sufficient of itself to refute the whole of Meneghini's theory. But if, disregarding this fact, we imagine the lowest internode, the cicatrix of which in the stem under consideration was 39 lines in circumference, to undergo the change described, this would obtain, by the addition of $\frac{1}{5}$ of the size of the base of the leaf, a circumference of 47 lines. In this expansion the next internode above must share, since we always find the stem of *Aletris* to be nearly cylindrical. But the part of the leaf next above, which lies only a couple of lines to one side, is situated only about three lines above the borders of the lowest leaf, from which we set out.

With such a short distance between the lower and upper leaf, the expansion of the lower internode must be continued into the part of the upper leaf which stands vertically above the growing portion of the lower internode; since the fibres, which would form the piece of stem inserted between the borders of the leaf of the lower internode, must, like all other fibres of the plant, be continued in a tolerably straight direction upwards in the stem; hence the cicatrix of the second leaf must become wider. The second cicatrix, in the stem in question, is likewise 39 lines broad, but we must add about eight lines for the expansion of the lower internode; therefore, we obtain 47 lines as its breadth. If we next suppose, in accordance with Meneghini, the growth in like manner of a piece $\frac{1}{5}$ of the breadth of the leaf between the borders of the leaf of of the second internode, the circumference of this internode would be increased at least nine lines, and we thus obtain a circuit of 56 lines. This internode would, consequently, exceed the lower about nine lines in circumference. Since we do not find this in nature, and since we must assume that the fibres which grow between the borders of the leaf of the second internode must be continuous into the lower internode, we are compelled to assume that the lower internode shares in the expansion of the upper, and, consequently, also acquires a circumference of 56 lines. But if, now, that which occurred in the second leaf hold also exactly for the third, its middle portion must expand about nine lines in breadth, because a piece of stem equal to one sixth of 56 has grown beneath it, in the internode of the second leaf. The breadth of the second leaf amounted to 47 lines; the third would, therefore, be 56 lines broad. Then allowing the borders of the leaf to separate about $\frac{1}{5}$ of the breadth of it, we obtain 67 lines for the circumference of the internode. In this enlargement, the lower internodes again naturally take part; we have, therefore, raised the circumference of the stem from 39 to 67 lines by these changes of only three internodes, and yet we are still far below

the size which the stem must acquire, since this expansion of the lower internodes would again be followed by an expansion of their cicatrices in breadth, which would again necessitate an increased expansion of the part of the stem lying between the borders of the leaves (for this part should equal $\frac{1}{3}$ of the cicatrix); and in consequence of this, the upper leaves would be again expanded in breadth, which expansion would react again upon the lower internode, and so on. It is easy to see that this cannot be the proceeding which nature follows in the growth of these stems, since it would lead to an immense increase of thickness, even if it were restricted to a condition where the margins of the leaves were separated about $\frac{1}{3}$ of the breadth of the leaf at the complete development of the latter; and that in *Dracæna*, where the separation of the margins of the leaves would equal double the breadth of the latter, the increase of the diameter of the stem must occur in a far more excessive proportion. Since, therefore, on the one hand, these conclusions, which are necessary deductions from the processes asserted by Meneghini to occur, would lead to impossibility, and, on the other hand, both direct observation of the cicatrices and the anatomical examination of the stem testify most clearly against this notion of an unequal growth of the leaf-scars and the circumference of the stem, the divergence of the fibres from the perpendicular line cannot be caused by the mechanical process supposed by Meneghini.

Even if this oblique direction of the fibres were a consequence of the unequal growth of the leaf-scar and the circumference of the stem in *Dracæna*, *Aletris*, &c., this derivation of it would not be applicable to the Palm-stem, since this always has its leaves and leaf-scars surrounding the stem. Meneghini did not overlook this circumstance; but he imagined he had discovered a second mechanical cause, which produced an oblique position of the fibres also in the stems with completely amplexicaul leaves, and which consisted in a movement of the leaves to one side.

He starts from the fact, that the leaves of the arborescent Monocotyledons, e. g. of *Yucca*, lie in a heliacal line, which in the flattened bud of these plants passes into a true spiral. The heliacal line marks a constant relation; this does not exist in the spiral, for this passes, with the further development of the leaves lying in it, and the conversion of the bud into stem, into the heliacal line running upon the side of the stem; in this, the same lines still remain, since they always gain at their inner end as much as they lose at their outer end by passing into the form of a helix. Each leaf originates in the centre of the bud, and passes, when a new leaf arises in the centre, into the place of the preceding one, till at last it comes to be situated on the outer surface of the stem. In this movement each leaf follows a spiral course, in which the mutual relations of the leaves remain the same, and all the leaves are carried back uniformly. Each leaf therefore exhibits, besides the movement from within towards the outside, and from above downwards, also a horizontal motion in a spiral direction; on the first of these motions depends the divergence of the vascular bundle from the vertical line; the second gives rise to a divergence in the horizontal direction, since the upper part of the vascular bundle, running from the centre of the stem to the leaf, follows the lateral motion of the latter. Since the turns of the spiral are closer in the middle, and the motion of the leaves becomes slower in proportion as they pass further out, the greatest bending of the vascular bundles takes place in the centre of the stem (l. c. p. 16.)

Against the idea that, in the development of the terminal bud into stem, the leaf-spiral passes into a helix, and that each leaf traverses the length of this spiral, no objection can be urged; this traverse of the spiral, however, is only a seeming movement, and by no means connected with an actual motion to the side. If Meneghini's idea were correct, it is clear that the most external leaf seated on the spiral, could not advance with it in a lateral

movement towards the surface of the stem, without the divergence between it and the uppermost leaf upon the helix becoming diminished, until the leaf had arrived at the lateral surface of the stem, and there become permanently fixed. It is equally clear that if the rest of the leaves should follow this first at uniform distances, from the turns of the spiral being closer towards the interior, the divergence between the successive leaves would increase in proportion as they were situated more internally, and would first acquire the dimension normal for the species at the transit of these leaves over on to the heliacal line. On the other side it is likewise evident that, without any alteration of their divergence, the leaves would seem to traverse a spiral, if each of them proceeded towards the periphery upon the radius on which it stands at its first origin; for during the expansion of the axis of the bud, its most external part extends outwards and upwards to become the surface of the stem, the outer end of the spiral running upon this part of the axis, passes, as a continuation of the helix, on to the outer surface of the stem, and the succeeding leaf advances just so much nearer to the end of the spiral line, not because it makes a lateral movement upon it, but because the spiral line is abbreviated in the direction towards the leaf, and its point of transition into the helix advances nearer to the point at which the radius, on which the leaf stands, intersects the circumference of the stem. Which of these processes occurs, whether the leaf actually advances laterally, or the motion is only apparent, may be decided by investigation whether or not the divergence of the leaves alters. Now I believe that it will be found on examination of the position of the leaves, that they exhibit the same divergence in the terminal bud as on the stem, and that the arrangement of the leaves passes with uniform divergence from the helix into the spiral, and is continued in this; while, according to Meneghini's idea, the divergence must increase in the spiral. The distance from a leaf to its successor on the spiral will naturally be

shorter, looking at its absolute size, the nearer it is to the inner end, but the angular divergence of the leaves will be the same. If this be the case, and I believe that all investigations hitherto made testify that such is the condition, it is evident that the movement of every leaf takes place in the radial direction, and is simply a consequence of the elongation and expansion of the axis; that the motion of any leaf in a spiral direction is only apparent, and results from the fact that the spiral line has no definite place upon the upper surface of the bud, but its point of origin continually advances in the direction in which the leaf-spiral runs, into the circle which is formed by the connexion of the cylindrical surface of the stem with the depressed surface of the bud. If such be the condition, the leaves must appear to traverse the outer turns of the spiral more rapidly than the inner, since the same angles of divergence correspond to larger segments of turns in the outer parts of the spiral, while, according to Meneghini's theory, the contrary occurs: the motion of the leaves diminishes in regard to the angle of divergence in the outer turns of the spiral, but in regard to the spaces passed through remains the same, and thus must appear to become slower. Sinee, although I had investigated the terminal buds of some large Monocotyledonous plants in reference to this point, and had found no notable deviation with regard to the divergence of their leaves, my judgment on this matter could not be nearly so valuable as that of my honoured friend, Professor Alexander Braun, I wrote to ask him whether he had ever met with cases of such a deviation in the divergence in the terminal bud as is required by Meneghini's theory, and obtained the answer, that he is indeed of opinion that it is very difficult to settle this point with certainty by direct observation, but from his own researches, he believes the divergence in the terminal bud to be the same as in the stem. From this important confirmation of my views, it appears to me that the entire doctrine of an actual spiral motion of the leaves, and the deduction from it of the oblique

direction of the fibres, must be thrown aside. There are still further reasons against Meneghini's asserted lateral motion of the leaves. If the oblique direction of the fibres were caused by such a motion, it is evident that all the fibres ought to run in the same direction (right or left), since this movement of the leaves must have the same effect as a twisting of the stem. Therefore, if a Palm-stem be split longitudinally, the split surface ought to follow that spiral in which the fibres run in the stem, and no fibres should be torn by such a splitting, as they would all be homodromously curved in their course downwards from the centre of the stem. I investigated this condition in a stem of the Brazilian Palm, which has lately been imported for manufacturing purposes, in lengths of about seven inches. The split surfaces of this stem never run in an oblique direction, but always parallel with the axis, and a considerable resistance is offered in the process of splitting, since, in the split, not only are fibres running parallel separated, but a very great number of the fibres of the stem must be torn across, because one portion of the fibres runs obliquely through the stem from right to left, and another in the opposite direction. Thus, in reference to this oblique direction of the fibres, exactly the same condition occurs in the Palms as in *Dracæna*, *Yucca*, and still more evidently in *Xanthorrhœa*, in which the fibres running right and left lie in alternating layers surrounding the stem, exhibiting in the cross section some resemblance to the annual rings of a Dicotyledonous stem.

It is sufficiently shown by the preceding observations, that the explanation given by Meneghini of the oblique course of the vascular bundles cannot be correct, either in *Dracæna*, or in the stems which have amplexicaul leaves; we must seek the reason of it, not in mechanical causes, but in the organic activity of the plant.

In reference to the vascular bundles of the root, Meneghini observed that in a young *Chamærops* they passed directly into the vascular bundles of the leaves; but that in the roots breaking through higher up on an

old stem, the condition was different, the greater number of their vascular bundles being lost in the outer woody layers of the stem, only solitary fibres curving upwards or downwards, to run further beneath the rind. In the roots of many other arborescent Monocotyledons he constantly saw the vascular bundles, if the root were still young, spread out like a star over the woody layer of the stem; in older roots, on the contrary, they penetrated deeper into the stem, where they then ramified and lost themselves. Meneghini derives these differences from the different conditions of the course of the sap; the main root (tap-root) and the lowest roots of the stem are formed at the same time, and with the help of the same currents of nutrient sap, as the vascular bundles of the stem, the latter, therefore, pass directly into the fibres of the former; but when roots are formed on the older parts of the stem, the currents of sap cause a stellate expansion of their vascular bundles on the surface of the woody mass of the stem.

Unger has given some contributions to the knowledge of the Monocotyledonous stem, having, in his researches on the Dicotyledonous stem (Ueber den Bau und das Wachsthum des Dicotyledonenstammes, 1840, p. 35), taken a comparative glance at the structure of the Monocotyledons, and, more particularly, subjected the stem of the *Aloineæ* (*Dracæna*, *Aletris*, *Yucca*, *Agave*) to a more minute investigation. With regard to the course and anatomical peculiarities of the vascular bundles, Unger agrees in general with the description I have given, and thus nothing need be said on this point. But from his investigation of the course of development of the vascular bundles, he has been led to propound a definite opinion as to the import of their proper vessels, while I had let this point remain untouched. He traced the development of the vascular bundles principally in the *Aloineæ*, and states that their rudiments are uniformly cellular, that the other systems (the wood and liber portions) make their appearance subsequently at the inner and outer

sides, and that their intermediate portion is to be regarded as their most essential part, since it is not merely that first originating, but also, in all stages of metamorphosis of the vascular bundle, persists under the same form of elongated cells, resembling milk-vessels.

In reference to the blending of the vascular bundles with each other, Unger distinguishes the proper blending (*coalitus*), which consists in the actual fusion into one vascular bundle, from the mere apposition (*symphysis*), in which the vascular bundles are attached together by a dense parenchyma. According to Unger, true blending does not occur in the *Aloineæ* (with the exception of *Yucca gloriosa* and *Agave Americana*), while in other families, especially in the Scitamineæ and Bromeliaceæ, it is frequent.

Of the systems of vascular bundles of the buds and roots of the Grasses, it is stated, that they are special to these organs, and do not pass into them from the stem; this is particularly evident in the roots, but in the vascular bundles of the buds also, a mere anastomosis with the vascular bundles of the stem occurs, and only individual ones become mingled with those of the stem.

With regard to the period at which the vascular bundles running to a leaf originate, Unger found that the slender fibres occurring in the Palms and Grasses, which do not enter into the interior of the stem (at least, certainly not in the Grasses), are of later origin than the stronger vascular bundles which run from the inner layers of the stem into the leaves.

Lestiboudois expresses an opinion very different from that of his predecessors, in reference to the mutual blending of the vascular bundles, in his very valuable treatise on the Structure of the Stems of Plants (Études sur l'Anatomie et la Physiologie des Végétaux, 1840), in which he has wholly relinquished his earlier views of the structure of the Monocotyledonous stem.

The Palm-stems examined by Lestiboudois belonged to species, the systematic names of which are unknown

to him; they were chiefly two stems, imported for commercial purposes, one of which has black, the other red fibres. Lestiboudois believes the slender fibres of the outer layers to originate partly from the cellular rind, and partly in the form of branches of the larger fibres; and he states that, in consequence of manifold ramifications and lateral connexions, they form a continuous network. In the upper end of the fibres, entering the leaf, he likewise finds not only, frequently, a division of them into several branches, entering separately into the leaf, but also when they enter undivided into the leaf, dense ramifications which become blended with other fibres. He further assumes that the fibres are not all formed at the periphery of the stem, but that from the central vascular bundles, and from those running in the hard, woody layers, slender fibres, like those lying beneath the rind, run out; and from this he draws the conclusion that it is clear that all fibres are destined to produce new fibres. The particular fibres do not, indeed, run in unbroken continuity through the whole stem, but the fibres of the different parts of the stem are so connected that they spring out from one another, and before they emerge into the leaf, give off branches, which are destined to replace, in the upper part of the stem, the fibres emerging into the leaves lower down. From this it is clear, that in the Monocotyledons the life is not exclusively seated in the outer layers; if the stem be cut into all round, down to the hard layer, in a *Yucca* or *Aloë fruticosa*, the plants will live, unhurt, for many years; the only phenomenon which appears in the wound, being the formation of a protruding collar on the upper border of the incision, from out of which numerous roots frequently break forth.

Before I follow the author further in his exposition, I have to state, that I am very far from implying a doubt of the correctness of his observations, but yet I cannot forbear from questioning the universality and frequency of these ramifications in the vascular bundles of the Palms. I have stated above, that in particular stems of the *Cocos*-

like division, for instance, in *Lepicodaryum gracile*, I had found many slender evascular fibres among the perfect vascular bundles, in the interior of the stem; in the stems which I examined I could not trace the origin of these fibres, and therefore cannot say whether they were formed by ramification of the vascular bundles, as in Lestiboudois' stems; in any case, however, the occurrence of these fibres is quite unusual, and to be regarded as an anomaly in the stems of Palms, and I found none of them in the Palm-stems which are met with in the shops with us, and which, doubtless, belong to the same species as those which Lestiboudois calls "the Palms with black fibres." That the vascular bundles do not all end below in a slender fibre lying beneath the rind, but that it does happen a fibre becomes blended with another at its lower extremity—i. e. in tracing the fibre from below upwards, it appears like a branch of another fibre—I have likewise mentioned; but this condition occurs only in very few fibres. As to the condition of the multitude of thin, lower fibres lying beneath the rind, whether they are lost in the cellular tissue or blended with other fibres, I am unable to say, for the solidity of the tissue in this situation rendered it impossible for me to make out this point accurately. An anastomosis of these ends of the fibres into a connected reticulation (as in *Yucca*, *Xanthorrhœa*), decidedly, I believe, does not occur; only with the existence of such would such a universal connexion of the fibres with each other occur, as Lestiboudois claims for the Palms. I cannot find in the Palms a connexion and ramification of the upper parts of the fibres, like that described by Lestiboudois, I therefore think that their assumption by Lestiboudois is rather deduced from the analogy of the Palm-stems with those of *Yucca* and *Aloë*, than founded on actual extensive researches on the former. Lestiboudois found this ramification of the fibres in a high degree in *Yucca*, *Aloë fruticosa*, and especially in *Pandanus*. When he deduced from these observations the conclusion that the fibres of the Monocotyledons are

formed in a different way from those of the Dicotyledons, originating from ramification of the old vascular bundles, while in the Dicotyledons the new fibres are deposited between the bark and the ends of the older fibres which emerge into the leaves, this conclusion is not justified by the anatomical character of the Dicotyledonous stem, since it leaves wholly out of sight the fact, that in very many Dicotyledons the lower end of some of these vascular bundles stands at least in quite as close organic connexion with other vascular bundles as in the Monocotyledons; so that the younger vascular bundles have much resemblance to those of the Fern-stem in respect to the arrangement and union.

Lestiboudois devoted especial attention to the roots of the Monocotyledons; from the examination of them he drew two conclusions: 1. Their vascular bundles are not formed by gradual elongation of those of the stem. 2. Their growth is endogenous, for their vascular bundles are perfected from without inward, and new vascular bundles originate in the interior of the root.

Schleiden (Wiegmann's Archiv, 1839, p. 220; Grundzüge der wiss. Bot. i, p. 220) directs attention to the point that the vascular bundles are developed in a similar manner in the Monocotyledons and the Dicotyledons, the part turned towards the interior being that which first originates, and he considered it to be the only thorough distinction between Monocotyledons and Dicotyledons, that in the latter the formation of new elementary organs proceeds indefinitely in the cambium-layer of the vascular bundle (whence he calls these vascular bundles *unlimited*), while in the former this development ceases at a certain epoch (*limited* vascular bundles), and the elementary organs of the cambium-layer assume the peculiar form in which I have described them under the name of proper vessels. With regard to this distinction, the knowledge of the facts on which it depends is not new, only the explanation, in so far that Schleiden quite correctly explains the continuous deposition of new layers of wood in the

vascular bundle of the Dicotyledons as a growth belonging to the vascular bundle itself, while I had derived it from the interposition of the lower ends of younger vascular bundles, running to leaves situated higher up, between the liber and wood of the old bundles; a theory against which Unger, also, has declared himself with convincing reasons (Ueber den Bau und das Wachsthum des Dicotylenstammes). Perhaps it may not be superfluous to remark, that this distinction only refers to part of the vascular bundles of the Dicotyledons, since the part entering the leaf and traversing it is likewise limited in its increase of thickness.

I now turn to Mirbel's excellent essay on the Structure of the Date-palm (Comptes rendus de l'Académie des Sciences, 12 June, 1843). In 1839 the author went to Algiers, in order to have an opportunity of examining a full-grown Date-palm in a fresh condition; and as the result of four years' labour, directed especially to the investigation of the terminal bud of this Palm, he laid before the Paris Academy a theory of the structure and growth of the Monocotyledons, which is opposed to my statement in several points.

With reference to the connexion of the roots with the stem, Mirbel agrees on the whole with my views, but assumes a more intimate connexion of the vascular bundles of the roots with those of the stems, than I met with in my researches. According to his statement, the fibres which come from the middle and neighbouring parts of the root, penetrate into the interior of the stem, between the vascular bundles of the latter, and lose themselves among them, in such a way that their extremities cannot be accurately made out, while fibres derived from the circumference of the expansion formed by the root in the stem, are distributed upwards and downwards, in the superficial layers. In reference to the latter, Mirbel thinks that they probably furnish contributions to the suckers which break forth abundantly from the base of the stem in the Date-palm and *Chamærops;* of the former, Mirbel

thinks they may stand in connexion with the leaves. When Mirbel then proceeds, that my statements as to the relations of the vascular bundles of the roots to those of the stems are not contradicted by this, but only carried out to their real extent, I am far from calling in question the accuracy of the observations made by Mirbel on the Date-palm, but must defend myself from the construction which must almost necessarily be attached to Mirbel's expression, that, namely, my observations, and the conclusions to be drawn from them, had been essentially modified, and that a more direct transition of one part of the vascular bundle of the root into that of the stem occurs universally. The essential point which I established by my observations on the roots of Monocotyledons, is the fact that the root is an independent structure, possessing its own special system of vascular bundles, that these are not gradually elongated outwards, towards the point of the root, but also increase in length in the posterior extremity, lying in the stem, penetrate into the stem from the cellular mass which constitutes the basis of the root-bud,—form an interlacement with the vascular bundles of the stem, and become attached to them.

All doubt as to this independence is removed by the investigation of the root-bud, for its vascular bundles are originally entirely separate from those of the stem ; but it is also perceptible, subsequently, that at least the greater proportion of them are not directly continuous with the vascular bundles of the stem, but, with an alteration of their structure, an interlacement is formed, in which they apply themselves to the sides of the vascular bundles of the stem, without actually passing over into them. The bundles of the branches of the root stand in the same relation to those of the root as the latter do to those of the stem. On account of the smaller number of vascular bundles of the root-branch and the root, and the very different diameter of the vessels of these two organs, it may be observed, with the greatest certainty, that an immediate transition of either set of vascular bundles into the other

does not exist. This investigation is far more difficult at the place of union of the root with the stem; but in a few Palms, particularly in a *Cocos* stem, in which the cellular tissue had been destroyed by rotting, I examined, at the point of entrance of several roots, the interlacement which their vascular bundles formed with those of the stem, and traced separately all the vascular bundles which ran through these, without finding a transition of a root-bundle into a stem-bundle; I therefore think that I may safely deny the occurrence of such a transition, at least in these cases. At the same time I do not wish to question, that in other cases part of the vascular bundles entering the stem from the root become mingled with the bundles of the former, and run on with them, as I have myself stated this to be the case with the fibrous bundles, which, in some Palms, lie with their lower extremities in the rind of the root, and as Meneghini found in the isolated fibres of the woody portion of the roots of *Chamærops*; but I believe I may deny that this condition occurs always and necessarily, and that a conclusion adverse to the independence of the vascular-bundle system of the Monocotyledons is to be deduced from it.

In regard to the structure of the stem, Mirbel directed his attention chiefly to the settlement of the question, whether the vascular bundles grow downwards from the leaves into the stem, or are developed in the contrary manner. He is in doubt whether, in my description of the Palm-stem, where I have described the course of the fibres downwards from the leaf, I merely intended to denote the mechanical conditions of their position, or the direction in which they are formed. I scarcely think that I could have expressed myself more distinctly on this point, that I meant only the former. I was unwilling to propound any definite opinion on the second question, because, in the absence of sufficient material, I was unable to solve it with certainty.

Mirbel first investigates the question, whether the vascular bundles run down from the leaves to the base of the

stem, and founds his answer on the following considerations. His Date-palm was 18·60 meters high, the base, clothed with roots, 34 centimeters in diameter; above the root-bearing part the surface of the stem had suffered from the influence of the atmosphere, and its diameter here amounted to 25 centimeters; the upper part was covered with leaf-scars, and almost cylindrical. Mirbel then concludes, that if the fibres originated in the leaves, and all reached down to the base of the stem, or, on the other hand, if all the fibres originated at the base of the stem, and ascended up into the leaves, the stem must necessarily have a conical form, on account of the accumulation of the fibres at its lower end. In like manner is opposed to either of these views a circumstance, which was undoubtedly known to me, namely, the spindle-shaped expansion of many Palm-stems in the middle, which I could not explain according to my theory, but which affords nothing remarkable now he has found that the fibres originate at all heights in the stem. The most certain evidence, however, against the opinion that the fibres run from the leaves to the base of the stem, is furnished by the following exact measurements. In the Date-stem he examined there were 337 leaf-scars on a length of one meter, the entire stem had, therefore, borne about 6268 leaves. At the base of one petiole Mirbel found 500 fibres 1 millimeter thick, and 400 fibres $\frac{1}{9}$th of a millimeter, which he estimated equal to 44 of the larger fibres; for the vagina of the leaf he reckoned 100; therefore, altogether, 644 for a leaf, and for all the leaves of the stem added together, 4,036,592 fibres. Besides these, account must also be taken of the fibres which run to the spathes and flower-stalks, and, moreover, the enormous number of capillary fibres which occupy a considerable space in the hard and firm crust of the oldest portions of the stem. Leaving these last out of sight, the fibres running to the leaves furnish a sufficient proof against my theory, since, if these fibres ran down to the base of the stem, the cone formed by them at the bottom would

be 2·01 meters in diameter, and 6·33 meters in circumference, while, in reality, the said stem was only 25 centimeters in diameter above the root-stalk.

Before I follow Mirbel's researches further, I must subjoin a few words to the foregoing. In the explanation of the structure of the Palm-stem I have called attention to two circumstances, to the course of the fibres, and to the alteration of their structure and size in different parts of their course. To the latter point, Mirbel, in advancing the preceding calculation in opposition to my view, paid no attention, but it was necessarily required that he should have done so, to afford any useful result. Mirbel says the Palm-stem swollen in the middle is a complete contradiction to my theory. The fact that such stems occur was well known to me, but by itself it was not of sufficient importance to give rise to a different theory. That with the development of the stem and the increase of the force of its vegetation, the upper leaves are larger than the lower, and a greater number of fibres run from them into the stem, than from the lower; that the stem must consequently acquire greater diameter at the base of these leaves than at the base of the lower leaves—all this is exceedingly simple. This increased thickness must be continued to the lower part of the stem, and the latter thus acquire a conical shape if the vascular bundles run down without change of thickness to the base of the stem, but by no means if, at the place where they appear beneath the surface of the stem, they become so slender, that in spite of their accumulation they still form no equivalent for the greater size of their upper ends, situated higher up in the stem. The plates of my 'Anatomy of the Palms' afford evidence of how considerable this attenuation is; they are drawn with the Sömmering's reflector, the relative sizes of the various parts of the same figure are therefore accurate, and a comparison of the vascular bundles with the thin fibres lying beneath the rind, shows that the transverse section of the latter is frequently a hundred times smaller than

that of the former. With this considerable attenuation of the vascular bundles at their lower extremities, with the more distant position of the upper parts of them in the interior of the stem, and with the crowded position of their lower filiform extremities, even if the fibres did run down in the stem, the lower part of this would only undergo a relatively slight increase of thickness, and a spindle-shaped thickening in the middle would still always be possible. Mirbel, on the other hand, reckons as if all the vascular bundles arrived at the base of the stem of the same thickness as they are when they emerge from the leaf, and comes to the conclusion, that in his stem the mass of these fibres would form a cylinder, which in the transverse section would display a surface nearly sixty-four times larger than the cross section of the stem actually was. To make a calculation of any use, it is necessary to settle the thickness of the lower end of the fibres. I have before me the discoid slice of a full-grown stem of *Phœnix*, 34 centimeters in diameter, in which the fibres lying beneath the rind average 0·127, therefore nearly $\frac{1}{8}$ of a millimeter in diameter. Consequently, if we assume with Mirbel that the upper and middle portions of the fibres are 1 millimeter in diameter, the cross section of about 64 of these fibres would equal it. If, then, all the vascular bundles reached the lower end of the stem under the form of such slender fibres, taking the number of vascular bundles of Mirbel's stem, the sum which he obtained must be diminished sixty-four times, i. e. the mass of these fibres would form a cylinder of the thickness of the Palm-stem Mirbel examined. I do not at all intend to attach any weight to this calculation, its incorrectness is too evident, since, according to it, the stem would consist of a compact fibrous mass; but it shows that a calculation, if not based on much safer grounds than Mirbel's rests on, cannot lead to any useful conclusions.

I admit unconditionally that my statement, that the vascular bundles run down, in the form of fibres, to the

base of the stem, is incorrect as regards the Palms. I was led to the assumption by the investigation of too young specimens (for I only had such in an entire condition, and the portions of full-grown Palm-stems at my disposal were merely short pieces), as well as by too wide an extension of the analogy with the stems of *Dracæna, Yucca,* &c. The grounds on which I now hold the view that the fibres run down to the base of the full-grown stem is false, are anatomical. It is clear, that in the transverse section of an old Palm-stem, we ought to find beneath the rind the fibres which are only just beginning to be formed, as Moldenhawer states that he did, although he had indeed no large stems to investigate; now in the examination of sections of old stems I have not seen this, but all the fibres lying beneath the rind were composed of thick-walled cells, consequently were old. A subsequent growth of the fibres beneath the rind of full-grown stems, therefore, does not take place. The matter is altogether different in respect to the stems of *Aletris, Dracæna,* &c.; here there is a layer beneath the rind perfectly comparable with the cambium-layer of the Dicotyledons, in which parenchymatous cells and fibrous bundles grow subsequently, which formation of new structures gives rise to continual increase of thickness of these stems. It is proved by this that the fibres terminate higher up in the stem in the Palms, and that in them must exist a condition similar to that in many Dicotyledons, where the vascular bundle can only be traced down through a certain number of internodes.

Passing now to the most important part of Mirbel's treatise, the examination of the terminal bud, he states that he found two slits, one above the other, in the centre of the flattened, concave, excavated apex of the stem, composed of nascent cellular tissue (to which he applies the name of *phyllophore*), these slits dividing the cellular tissue into superimposed layers. Of these layers each, according to his views, represents a nascent leaf; the upper one is elevated into a vesicle, and this becomes

torn away, in a circular direction in the greatest part of its circumference. The isthmus is developed into the petiole, the upper part of the vesicle becomes erected, acquires the shape of a spoon, and is converted into the leaf, the vagina of the leaf appears to grow out from the wound which the torn leaf leaves upon the phyllophore. The leaf acquires the form of a hood, its border having an irregular thickening; the two lateral halves of the hood are formed of the two series of leaflets, and the thickened edge, which unites the points of the leaflets, subsequently becomes absorbed.

The description of this process does not agree in the least with what I observed in regard to the earliest period of the formation of the Palm leaf. I examined, in reference to these statements of Mirbel, the terminal buds of *Phœnix* and *Cocos flexuosa*, but found, as in other Monocotyledons, such as *Agave*, *Yucca*, no trace of origin of the leaf under the form of a circularly torn vesicle as described by Mirbel, but saw the leaves shoot forth from the axis in the form of obtuse papillæ. This papilla is at first narrow, in proportion to the portion of the axis on which it stands, since the first-formed part of it corresponds to the apex of the future leaf; the further it is developed, the more the base rises from the surface of the stem, so that in the Palms an indication of the vagina of the leaf is visible at a very early period. I cannot understand how Mirbel came to the idea that the leaf originates in the form of a vesicle, and that several such vesicles lie one above another; he must have been led to this view by a longitudinal section which did not pass exactly through the axis of the bud, and thus have met with sheaths of young leaflets (which in the inner parts of the bud are not cylindrical, but have the lower part spread out almost flat), and have taken them for the rudiments of the whole leaves. I deduce another reason against the assumption that the leaflets originate from closed vesicles, from the observation of a monstrous formation which I found in a branch of *Phœnix*, the axis of which had grown out to the length

of some two inches. About six leaves on this had no amplexicaul vaginas, but the lower sheath-like portion of all the leaves formed a connected lamella, passing round the stem in a spiral line, from the upper part of which normally-formed leaves were given off at intervals. The upper leaves had perfectly closed sheaths. Similar confluence of several leaves into a continuous leaf-spiral have, as is well known, been repeatedly observed in plants with verticillate leaves, ex. gr. in *Casuarina*, whether they have elsewhere occurred in amplexicaul leaves I know not; in any case, the case just described appears to me inconsistent with the idea of the origin of the leaves in the form of closed vesicles.

The development of the originally simple leaf into a pinnate leaf is very peculiar in the Palms. Since Mirbel rather indicates than describes this process, a more minute explanation of it will, though not very closely connected with the object of this essay, perhaps be acceptable to many readers. De Candolle, in his 'Organography' (i, 304), has already observed, that the division of the Palm-leaf into pinnæ, or into lobes of a fan-shaped leaf, takes place in a manner altogether peculiar, namely, by a tearing up of the structure. De Candolle looked at this process much too roughly; he evidently made his observations on a leaf already developed to a considerable degree; I was therefore quite justified in rejecting this notion of a mechanical description in my 'Anatomy of the Palms,' but in like manner did not go far enough back in the investigation of the young leaf, in its earliest stages of development, to enable me to give a satisfactory explanation of the process. I had indeed correctly made out that the separation of the pinnæ is completed long before the unfolding of the leaf, and that they are not connected together in the bud by leaf-tissue, but by a loose parenchyma, which is blended in a very narrow line with the border of the leaf, is connected with the pubescence of the leaf, and dries up and falls off with it, whereby the leaflets are allowed to separate from each

other and become free; when, on the other hand, I explained this tissue as a peculiar form of the pubescence, I was wrong, as the following observations will show. I traced the development of the leaf in *Phœnix* (pl. I, figs. 9-13) and *Cocos flexuosa* (figs. 1-8); in both, the young leaflets (figs. 1, 12, 13), until they attain the length of about five millimeters, are composed of a connected tissue, which in the middle, as rudiment of the future petiole, is thicker, and runs out into a relatively thin border at each side. At a later period a smooth furrow is formed between the thickened mid-rib and the margin of the leaf (fig. 2), at the bottom of which are subsequently met with, nearly approached, somewhat excavated cross-striæ (figs. 3, 4), the tissue of the leaf, however, being still continuous. These cross-striæ are afterwards converted into narrow slits (figs. 5-11), which in *Cocos flexuosa* penetrate the entire thickness of the leaf, so that they are visible on the upper and lower surfaces (fig. 7 *b*). The further development shows that the part lying between each pair of slits becomes perfected into a leaflet, and in a cross section (fig. 7 *c*), or, still better, in a longitudinal section, it is perceived that these pinnæ are folded together, and that the mid-rib, at which the fold takes place, is in *Cocos* on the upper surface, so that consequently twice as many slits are visible at the under side of the leaf as at the upper (fig. 7 *c*). The margin of the leaf, at which the points of all the pinnæ are blended, forms a continuous cellular mass, which ends externally (fig. 8*) in an acute angle (the border of the previously undivided leaf). With the advance of the development of the leaf this cellular mass dries up, and is thrown off in the form of a brown filament, by which the leaflets are set free. In *Phœnix* (figs. 9-13) the matter is rather different, as the mid-rib of the leaflets is turned toward the under side of the leaf, and the cellular mass which connects the pinnæ is not merely blended with their summits, but is continued over the whole of the upper surface of the leaf as a rather thick membrane,

and is blended with the upturned margins of the pinnæ, whence the slits between the latter are only visible at the under side of the leaf. The leaf, therefore, originates as a continuous mass, and the pinnæ owe their origin to an actual division of the leaf: the division, however, does not advance from the margin of the leaf toward the mid-rib, but relates only to the surface, not affecting the border, nor, in *Phœnix*, the upper layer of the tissue of the leaf. This permanently undivided mass of cells is distinguished from a true pubescence, to which it bears much resemblance, by its origin, since it is not a growth from the surface of the organ, but forms an actual part of the tissue of the leaf, as well as by the circumstance that in some of the Palms, for example in *Phœnix* (but not in *Cocos*), vascular bundles run into it.

Return we from this digression, to Mirbel's description of the bud. He states that there run through the tissue of the bud a countless number of transparent, very delicate fibres, which converge from the whole internal periphery of the stem toward the central portion of the phyllophore, where their upper extremities approach the young leaflets, sooner or later to enter into direct connexion with them. In a few instances he has hit upon these fibres at the moment when they were running into the weakly-indicated rudiments of the leaves. Those physiologists who believe that the fibres run down from the leaves had certainly never an opportunity of seeing the terminal bud of a vigorous Date-palm, or they would have left nothing for him to do. A glance is sufficient to convince that the upper ends of these fibres are very young compared with the lower, that they consequently grow from below upwards. If they sprang from the leaves, they must be old and hardened at their point of origin, long before they reached the base of the stem.

This proposition contains the nucleus of Mirbel's doctrine of the structure of the Monocotyledons. The remark that earlier labourers at the anatomy of Palms had no terminal bud of a vigorous stem to examine, is unfortu-

nately, in my own case, only too well founded, and if I venture, notwithstanding that I have not the appliances of the Paris Academician, to subject his researches to a criticism, I know well the difficulty of my undertaking, yet I hope that the reasons which I have to adduce will not be without weight. That the first glance at the section of a Palm-bud will not force the conviction upon every one, that the fibres grow from below upwards, is proved most decisively by Gardner saying, that the greatest sceptic would only need to see a longitudinal section of a Palm-stem bearing its leaves, to be convinced that its woody substance is formed from the leaves (Annals of Nat. History, vi, 61.) I unfortunately had no larger buds at my disposal than the terminal buds of a stem of *Cocos flexuosa* about two inches thick, and of young stems of *Phœnix*. From an examination of these buds, made in reference to Mirbel's views, I have nothing to object to the correctness of his anatomical statement, that in *Phœnix* the vascular bundles running to the young leaves of the bud, are harder and more developed below the phyllophore than in it, where they are in a soft, gelatinous condition. But does the conclusion deduced from this fact by Mirbel, that the lower parts of the bundles are older than the upper, necessarily follow from it? At first sight, undoubtedly, since it is a general fact that young woody bundles are soft, old ones hard. But it is a totally different question, whether the hardness of them is connected simply with their age, or at the same time and in a higher degree with the stage of development of the part in which the vascular bundles lie. Mirbel assumes the former; I believe the latter may be proved. Calling to mind that in the articulated plants with elongated internodes, as in the Grasses, Pinks, in *Ephedra*, a yet imperfectly-developed internode is already completely hardened above, where it is exposed to the air, while below, so far as it is inclosed by the sheath of the lower leaf or verticil of leaves, its internode is still of an herbaceous softness, we have here a case which stands in the most glaring contradic-

tion to the fundamental proposition on which Mirbel rests. Mirbel says, because in the Palms the vascular bundles are softer above than below, their lower portion is older, they consequently grow from below upwards; with equal right he would assume the reverse if he split an internode of *Zea Mays*. Moreover, if we remove the leaves from a terminal bud of *Phœnix*, we find in its half-developed leaves, which have attained a length of about 1 to 3 lines, the part of the petiole projecting from the bud already green and firmly lignified, while the base of the petiole and sheath are uncoloured and very soft; the vascular bundles of the upper part are found completely lignified, those of the lower portion still half gelatinous and translucent, in short, we find here between the upper and lower ends of the vascular bundles (only in reversed order) the same differences as in the vascular bundles of the stem. Shall we conclude from this that the vascular bundles of the leaves grow from above downwards, that the upper part of them is so much older than the lower? This no one will wish to assert, since in the Palm-leaf, it must be concluded, from the fact that leaflets still very small have a sheath, that the growth of the leaf depends on an expansion of the very young leaf in all directions, and not on a subsequent after-growth of its lower portion. From these circumstances, it certainly follows that the greatest differences of solidity and completion of structure occur simultaneously in different parts of the same vascular bundle, and may be caused by the transition from the rudimentary to the lignified condition proceeding with different rapidity in different parts of it, and going on parallel with the unequal growth of the organs in which the vascular bundle lies, since, in general, the upper part of the leaf attains its full development first, and, in the slowly-growing Palm-leaf, a long time before the lower portion; the same holds good in the vascular bundles of its petiole, and the direction in which their lignification proceeds, can by no means be regarded as an index of the direction in which their rudiments made their appear-

ance in their original formation. A vascular bundle which runs from the summit of the petiole of such a half-developed leaf, through the petiole and bud, to the outer surface of a part of the stem situated far lower down, may, according to what has just been said, exhibit its complete development and solidity at both ends, which lie in organs already completed and solidified, while its middle portion, in its course through the lower part of the petiole and through the upper soft portion of the stem (the phyllophore) concealed in the bud, is gelatinously soft, and, in reference to the anatomical completion of its individual elementary organs, still in a young condition. In the same proportion as these soft parts advance in development, as the part of the phyllophore through which the vascular bundle runs becomes part of the stem, and the petiole and leaf-sheath attain their full size and become solidified, will the soft part of the vascular bundle also increase in size and internal completeness, till its growth is finally terminated, and it is solidified. This, and nothing further, do we learn from a view of the section of a bud, and when Mirbel finds in the increase of solidity which the vascular bundles exhibit from above downwards, a proof of the direction in which they originate, the validity of this conclusion must be altogether contested.

The question, in which direction the vascular bundles are formed at their first origin, can only be decided by direct observation of the process of their origination; therefore, only by microscopic investigation. Mirbel did not neglect researches of this kind, and he states, that he sometimes caught the vascular bundles at the moment when they were betaking themselves into the rudimentary indications of the leaves. In the examination of the terminal buds of various Monocotyledons, especially in *Iris*, *Acorus Calamus*, of the bulbs of *Narcissus poeticus*, I came to the result, that the first indications of the vascular bundles, in the form of transparent streaks, are to be met with beneath the youngest leaves, in the axial portion

of the bud, before they appear in the leaves, and that, subsequently, the origin of the vessels in these rudimentary vascular bundles follows in the same direction. This result has been fully confirmed by the researches of Schleiden (Grundzüge, ii, 189), Meneghini (Intorno alla struttura del tronco delle Monocotiledoni, in Miscellanee di Chimica, Fisica e Storia naturale, 1843), and Naudin (Ann. des Sc. nat., 1844, i, 162); and after these accordant observations, there can be no doubt that the upper end of the vascular bundle grows from below upward, and that we have to seek its origin in the stem, and not in the leaf. But it is quite a different question, whether this process of development occurs throughout the whole of the vascular bundle, or if its lower end, running downward in the stem, grows in the opposite direction. Mirbel assumes the former, and assures us that in the Palms, the same vascular bundle has already, at its lower end springing from the interior of the periphery of the stem, the characters of developed wood, and exhibits in its intermediate parts, the half-solidified condition of the alburnum, while at its upper extremity it consists of nascent tissue. Has Mirbel really observed this? I here take the liberty to doubt. According to my own observations, the vascular bundle of a Palm, the lower end of which already exhibits a ligneous solidity, goes, not to the rudiment of a leaf, but to one already tolerably advanced in development; therefore, if the portion of it lying in the upper part of the stem be still very soft, from the causes explained above, this can give no further result as to the mode of its first production. We can only arrive safely at such by tracing downwards one of these vascular bundles, the upper part of which has not yet reached a leaf, and observing its further gradual development. From the great number and the entangled condition of the vascular bundles, I was unable to do this in a Palm-stem, and my efforts to make out this point by direct observation totally failed. When, in spite of this, I venture to discuss the question, and to deduce a decision

of it from more distant phenomena, I am fully aware that this proceeding can claim no certainty, but at most a certain degree of probability; I nevertheless hope that such a mode of considering it will not be altogether useless. In the first place it has to be inquired, whether a developing vascular bundle always grows in one direction, or whether cases do not occur where its two ends become elongated in opposite directions. In my opinion, the latter case undoubtedly occurs, especially at the point of insertion of a root upon a Monocotyledonous stem, and of a branch of one of these roots upon the main trunk. In both these cases, and especially distinctly in the latter, we see vascular bundles originate in the cellular node in which the formation of the root begins, the end of which toward the point of the root, increases in length with the further growth of the root, while the other end penetrates, in the opposite direction, into the stem or primary root. In an analogous manner, as is again to be observed more clearly in the Monocotyledons than in the Dicotyledons, the bud which is developing into a leafy branch, also possesses its proper system of vascular bundles, independent of that of the stem, the lower extremities of which pass into the stem, and spread themselves out over a lesser or greater portion of its ligneous mass. Now, these vascular bundles are nothing else than the inferior extremities of the vascular bundles of this branch, and the most ready supposition, on seeing these fibres passing over into the stem, is that they have been developed from above downwards. To this explanation, which immediately presents itself, it may certainly be objected, that the fact of the passage of that vascular bundle into the stem, does suffice to prove that this is perfected in the direction from above downward, for the formation of that vascular bundle in the stem itself may be caused by the presence of the branch, through the attraction it exerts on the sap-bearing substance of the stem, and it may grow from the stem upward into the branch. But the direction which the fibres lying beneath the rind of Monocotyledonous stems

assume when the stem is wounded, appears to afford an evidence that their formation actually does take place from above downward. I have before me the stem of a *Yucca,* in which many branches were sawn off from the surface during the life of the plant, and which had otherwise undergone injuries penetrating as far as the fibrous layer. On these wounded places over-growths have been formed, as in a Dicotyledonous stem, in which the fibres run down from above to the injured part, till they reach the upper border of the wound, then deviate to each side, run down along the lateral borders, and at some distance below the injured spot again approach together from each side, in a very acute angle. In this way an over-growth is formed above and at the sides of the wound, but is absent at the lower border. If the fibres grew upward from below, as Mirbel assumed, they should reach the lower margin of the wound, deviate to the side of it, and gradually approach together again above it; the overgrowth ought, therefore, to originate at the lower and not the upper side of the wound. It is to be observed here, that this over-growth is not effected by an increasing thickening of old vascular bundles, existing at the time of the injury, as in the Dicotyledons, but is formed by newly-developed bundles, which are entirely separate from those subjacent (as in general, also, in the normal growth of the stem, the superimposed fibrous layers are not to be compared with the annual rings of the Dicotyledons, but to be regarded as entirely isolated structures), which is most clearly shown in the direction of the spiral lines in which the fibres run, since these spirals alternate to the right and left, in the successive layers, in a manner analogous to what is found in *Xanthorrhœa.*

The analogy between the structure of the stem of a *Yucca* and a Palm is so great, that we are justified in drawing a conclusion from the phenomena we observe in the former, as to the processes occurring in the latter. The distinction between the two stems lies chiefly in this, that in *Yucca* the lower extremities of the vascular

bundles run down to the base of the stem in the form of a close fibrous network, and that in consequence of the continued deposition of new fibrous layers, the stem exhibits an uninterrupted growth in thickness, while in the Palms the lower fibrous extremities of the vascular bundles, as a general rule, remain simple, and do not run downwards to the base of the stem. The case observed by me in *Cocos*, of the solution of the vascular bundles into a number of slender fibres (p. 9) is to be regarded as an approximation, in the Palms, to the structure of this fibrous reticulation. These differences occurring between the stem of *Yucca* and that of the Palms are undoubtedly not of sufficient importance to allow of our supposing an essential difference to exist in the mode of development of the vascular bundles. Since, then, in every Monocotyledonous stem vascular bundles appear, in consequence of the development of a branch, which, without the formation of that branch, would not have originated,—since these vascular bundles form a greater mass, and spread so much more widely over the stem from the base of the branch, the older this latter becomes,—since in *Yucca* the course of the vascular bundles exhibits such mechanical conditions in the vicinity of a wound on the stem, as must result from a downward growth of the vascular bundles on the stem, it is quite justifiable for me to declare that Mirbel's view, that the vascular bundles of the Palms grow from below upwards, is an opinion opposed to the phenomena of the growth of the Monocotyledons; and to presume, on the contrary, that the lower portion of these bundles is developed in the direction from above downwards.

Meneghini came to the same result through a series of deductions altogether different from mine. He had already stated, in his first paper on the structure of Monocotyledons (Richerche sulla Struttura del Caule nelle Piante Monocotiledoni, 1836, p. 77), that the formation of vascular bundles was caused by definite currents of nutrient sap, without, however, carrying out this view more minutely.

In a more recent treatise (Intorno alla struttura del tronco delle Monocotiledoni), he sets up the following theory, as to the connexion between the currents of sap and the origin of the vascular bundles, and as to the dependence of the direction in which the fibres are developed on the course of the sap. The nascent leaf in the centre of the bud forms the focus of the sap-currents, which converge from the periphery of the bud to the leaf, and give rise to the production of vascular bundles. The portion of the vascular bundle which has originated in this way, forms, when the leaf, in the course of its further development, has passed out to the periphery of this stem, the inferior portion of its vascular bundle, since the upper part of it grows after that first portion, gradually, and in proportion as the leaf is developed and assumes its subsequent position. During the perfecting of the leaf, the sap-currents running in toward it, and with them the organization of the vascular bundles in the cambium-layer of the stem, undergo a continually increasing expansion in the direction from above downward. When the leaf has emerged from the bud, and has become green, the superabundant assimilated juices flowing toward it, together with the ascending sap, flow back, and give rise to the formation of liber-cells. The ascending sap, which is so much the less elaborated the nearer it is to the root which absorbs it, must influence the metamorphosis of the cells through which it flows, so much the more powerfully, the nearer it comes to the point by which it is especially attracted; therefore the formation of the vessels, which depends upon it, begins in the leaf and descends from here to the root. The descending sap, on the other hand, which is consumed in the nutrition of the cells, must lose its activity in proportion as it becomes removed from the leaves. The formation of the vessels depends on the ascending, that of the liber-cells upon the descending sap; the first, consequently, predominates in the upper parts of the vascular bundles, the other in their lower portions, and on double grounds

the vascular bundles must, in respect to the organic formation, be regarded as descending from the nascent leaf in the centre of the bud.

Returning to Mirbel's exposition, the manner in which the vascular bundles terminate below in *Phœnix* is not minutely described by him. Neither have I, as already observed, been fortunate enough to make out this point with certainty. It is indeed found, as I stated in my description of the Palm-stem, that a part of the vascular bundles becomes blended with others below, or as phytotomists who ascribe an ascending course to them express it, are branches from other vascular bundles entering into leaves situated lower down; but this condition can only be demonstrated in a very small portion of them, and, in particular, not in the capillary fibres, in which the vascular bundles terminate in the outer layers of the stem. It is probable, therefore, that the majority of the vascular bundles terminate blindly in the cellular tissue beneath the rind. This assumption may appear to create a difficulty in regard to the explanation of the manner in which the sap ascends, but we find exactly the same condition in the vascular bundles of the *corona* of many Dicotyledons—for example, in *Laurus nobilis*, *Quercus*, *Rosa;* where the vascular bundles running into one leaf run down the stem without entering into any connexion with those of another leaf, and become gradually attenuated under the form of thin fibres, which cannot be traced farther down. In these plants, the ascending sap, when it flows through one vascular bundle, must, to reach a second, emerge laterally into the cellular tissue, and from this flow into the neighbouring vascular bundles. The condition, however, as I have already several times remarked, does not occur in all the arborescent Monocotyledons, since in *Dracæna*, *Yucca*, *Xanthorrhœa*, the lower extremities of the vascular bundles grow together at their sides, and in this way form a connected fibrous reticulation over the whole stem.

Mirbel distinguishes different kinds of vascular bundles

in the stem of the Date-palm: 1st, those which occur in the interior of the stem, and form the principal mass of its wood; 2d, capillary fibres, which lie in great numbers in the peripherical region of the stem and the petiole, do not occur in the interior of the stem, and are thirty-six times smaller in diameter than the first. These thinner fibres contain no vessels, but are composed merely of elongated, thick-walled cells. In my description of the Palm-stem, I have likewise directed attention to these differences, and mentioned that the second class of fibres are the inferior extremities of bundles, which, without previously entering into the interior of the stem, run in the outer layers of the stem, and are here mostly converted into true vascular bundles. Unger was the first to remark that these fibres are of later origin than the vascular buudles lying in the interior of the stem; but Meneghini called especial attention to the circumstance, that, as a general rule, the different vascular bundles of the same leaf do not all penetrate to the same depth in the stem, and that this difference depends on the circumstance that the leaf, during its development, passes out from the centre of the axis to the periphery, and each vascular bundle only reaches that point in its internal curve, at which the leaf was actually situated at the moment when the organization of the vascular bundle commenced (Intorno alla Struttura del Tronco delle Monocotiledoni, p. 12).

Mirbel brings a portion of the vascular bundles prominently forward under the name of precursors (précurseurs). He applies this name to them because they are the first which become connected with the leaves. According to him, their number equals that of the leaves in each step of the leaf-spiral (de chaque pas d'hélice), and they appear at intervals, which are measured by the length of the internodes. They lie in a bundle in the centre of the stem; each of them proceeds singly out of this central bundle, and passes obliquely upward into a leaf. On its way, a number of other vascular bundles attach themselves to it. At the point where the precursor leaves the vertical

direction to repair to a leaf, it sends off usually one, more rarely two or three, branches, which ascend vertically upward, and probably run to leaves situated higher up. This is the only example of ramification of a fibre which Mirbel met with in the Date-palm.

The preceding, Mirbel continues, is not at all in contradiction to my statements; but this is not the case with the circumstance that the lower ends of the precursors do not run in a vertical direction down the stem, but repair to the side of the stem opposite to the leaf, whence it results that *all* the precursors which pass to each one of the turns of the leaf-spiral, cross in the central bundle, and form two cones connected at their apices—one erect, the other reversed. Whether the direction in which these fibres diverge from the straight line is the same in all, Mirbel does not express; nor does he make any mention of the fact, that Meneghini devoted especial attention to this point, or of the explanation of it given by that author. From his very laconic treatment of this point, which he speaks of as the most important difference between our works, Mirbel gives me no opportunity of making an accurate acquaintance with and discussing his views; for I must confess that it is not clear to me, from his treatise, how and why he distinguishes the fibres he calls precursors from the other developed vessels,—and that I know nothing of them.

ON THE

NUCLEI, FORMATION, AND GROWTH

OF

VEGETABLE CELLS.

BY CARL NÄGELI:

PART II.

TRANSLATED FROM

SCHLEIDEN U. NÄGELI'S ZEITSCHRIFT F. WISS. BOTANIK, 1846.

BY ARTHUR HENFREY, F.L.S.

VEGETABLE CELLS.

PART II.

In the First Part of this essay I endeavoured to demonstrate, in the first place, that nuclei occur in all vegetable cells, and that they are utricles; secondly, that in one kind of cell-formation (which is called *parietal* cell-formation), the whole contents of the parent-cell become divided into two or more portions, and that around each of these a perfect membrane is formed by the secretion of gelatinous substance, this membrane being in contact in part with the wall of the parent-cell, in part with that of its fellow secondary-cell. I shall hereafter find an opportunity of defending my theories against some objections which have since been made to them. I have delayed the continuation of the essay, which is principally to treat of free cell-formation, because my observations have never appeared sufficient to afford a quite positive conclusion. Even now, in spite of all my efforts, I have only arrived at probabilities in my results on many points, which, however, I will not any longer keep back, but leave the further development and establishment of the doctrine to a happier time.

IV.—FREE CELL-FORMATION.

a. Without visible nucleus.

In free cell-formation without a visible nucleus, the new cells originate, in the contents of the parent-cells, as minute globular bodies, in which, so soon as they have

acquired sufficient size, we recognise an enveloping membrane and inclosed contents.

In *Chlorococcus*, Grev., and *Hæmatococcus*, Ag., the new cells appear as green (in the former genus) or red (in the latter) globules, in which we only perceive a definite outline. When they leave the parent-cell and become larger, we distinguish a colourless membrane inclosing coloured contents. I have never been able to detect any sign of a nucleus. It appears as if merely small isolated portions of the contents became agglomerated, assumed a perfectly spherical form, and produced a membranous coat. The rest of the contents of the parent-cell are gradually dissolved.

Valonia utricularis, Ag., consists of one large cell. On the inner surface of its membrane lies the mucilaginous layer. The *germ-cells* (*Keimzellen*) originate in this. At first they have the appearance of minute drops of mucilage. The membrane cannot be detected until they have become larger, granular, and green.*

The origin of the germ-cells (spores) in the thecæ of Fungi and Lichens is accompanied by the same phenomena. At first they present themselves, sometimes in the form of homogeneous drops of mucilage, sometimes as little hollow globules, the former in clear, diluted, the latter in dense, mucilaginous, cell-contents of the thèca. In both cases the nascent spore-cell originally exhibits only a definite outline, and a distinct membrane only at a subsequent epoch.† No nucleus is visible in these; at a later period, when the cell has increased in size, and the contents have become transformed, a nucleus is seen in some instances.

In *Coleochæte scutata*, Bréb., the germ-cells appear in the parent-cells, at first as little green, homogeneous globules, on which a membrane afterwards becomes visible. A nucleus may sometimes be detected in the fully-de-

* For a more minute account, see Nägeli's New System of Algæ. (Die Neuen Algen-systeme, &c. Zürich, 1847.)

† See Nägeli, Linnæa, 1842, p. 257, Pl. ix, figs. 32, 34, 41, 45.

veloped cell in germination. The examples just given of *free cell-formation, without visible nucleus,* agree with each other in the point that the new cells first appear as little spherical, homogeneous portions of the contents of the parent-cell, around which no membrane, but merely a definite outline, can be perceived. They are, like the contents of the parent-cell, coloured (green or red) or colourless. Not until they acquire greater size, and in most cases, only at the time when they become granular, does the membrane become distinctly visible. A nucleus is never seen in the earlier stages, and appears subsequently only in isolated cases.

I have made a second series of observations on free cell-formation without visible nucleus in Algæ and aquatic Fungi, especially in *Bryopsis, Codium, Anadyomene, Acetabularia, Dasycladus, Conferva glomerata* (*lacustris et marina*), and *Achlya prolifera.* I regard it as an abnormal cell-formation, because it mostly occurs in older cells, and frequently simultaneously with the death of the rest of the cell-contents, or precedes this. If this mode of cell-formation occurs in healthy cells, containing, in addition to colourless, transparent contents, and homogeneous and granular mucilage, which is especially manifest as the mucilaginous layer investing the internal surface of the wall, also chlorophyll-globules and starch-granules, which lie principally in the mucilaginous layer,—at first we see minute, homogeneous, colourless mucilage-globules, the diameter of which is about ·002-·004 of a line. They become larger, finely granular, acquire a greenish colour, and a membrane gradually becomes visible upon them. Subsequently they acquire very various sizes (·010-·060‴), and contents which vary much in quantity, since the chlorophyll sometimes lies upon the wall in smallish quantity, and sometimes gives the cell a deep green aspect by its great abundance.

In the above cases the cells originate and are perfected, without immediately effecting any essential change in the contents of the parent-cell. But if the parent-cells have

begun to decay, the contents (the mucilaginous layer with the chlorophyll- and starch-globules) separate from the wall and lie effused in the cavity of the cell. In this case the new cells do not usually originate as small, colourless, homogeneous globules of mucilage, but as larger globules of the confluent cell-contents, composed of mucilage, chlorophyll, and amylum. On the very outside a layer of homogeneous mucilage is always deposited, and forms a sharply-defined surface. A distinct membrane is quickly produced on this surface. The cell-contents are so arranged within this that the chlorophyll- and amylum-globules lie at the periphery, while the middle part of the cavity is filled with transparent fluid.

These cells, whether they be formed within healthy or decaying cells, originate through *abnormal* cell-formation, and stand, apparently, in no necessary relation to propagation; therefore ordinarily they perish without further development. In isolated cases, however, they behave like germ-cells (spores), and are developed into new plants.

In Plate II, figs. 1 and 2 represent an old utricle of *Bryopsis Balbisiana*, wherein abnormal cell-formation is occurring. In fig. 1, *a* and *b*, the cell-contents are dead and beginning to dissolve. They consist of scattered chlorophyll-globules and mucilage-granules. The parts *c* and *d*, on the contrary, possess active living contents, surrounded by a mucilaginous layer. They are connected together by a mucilaginous cord: this cord is the remnant of the mucilaginous layer which formerly coated the part *a*. In an earlier stage it was thicker, and is now gradually becoming thinner. Fig. 2 represents the same portion of an utricle some time later; the connecting cord of mucilage has disappeared, which has resulted from its becoming gradually thinner, until it was torn across, and united perfectly with the two living portions of the cell-contents, *c* and *d*. The former, *c*, is now a defined, ellipsoid portion of contents, altogether free, and coated over its whole surface with a thin layer of homo-

geneous, colourless mucilage. The next and most important change which will occur in it is the appearance of an enveloping layer of membrane.

In fig. 3 is also represented a portion of an old utricle of *Bryopsis Balbisiana*. With the decaying and dissolving contents (chlorophyll, starch, and mucilage) occur small and large cells in various stages. Some are very small, and do not differ in appearance from a drop of mucilage (*a, a*); others are somewhat larger, finely granular, greenish, and already exhibit a delicate membrane (*b, b*); others again are tolerably large and green, with a distinct membrane (*c, c*).

Under the head of free cell-formation without a visible nucleus, the origin of the germ-cells (spores) of the Zygnemaceæ (*Spirogyra, Zygnema*, &c.) must also be mentioned. The facts of the case are well known; that two cells unite together (conjugate); that the septa of the point of junction become dissolved; that the contents of the two cells separate from their walls, and, either in the cavity of one of the two cells, or in the tube connecting them, become agglomerated into a globular or ellipsoidal mass, which becomes the germ-cell. All that observation shows, in reference to the last proceeding, is, at first, a mass of green cell-contents, with a definite outline, and subsequently the same mass of green contents inclosed in a membrane. There may be two hypotheses as to the formation of this membrane: 1, that it originates in the place where it first becomes visible on the surface of the contents; 2, that it originates as a minute cell in the interior, and, as it increases in size, gradually absorbs the contents.

In favour of the first assumption speaks, in the first place, the analogy with the abnormal cell-formation in *Bryopsis, Conferva*, &c., where the membrane is in like manner formed over the surface of the contents. Moreover, an additional support is derived from the circumstance that we can see nothing of any little cell in the interior, or of the alterations in the contents (solution and

reorganization of the solid structures, such as chlorophyll and starch), which must necessarily be connected with it. But that hypothesis is placed beyond all doubt by the following fact. It is well known that the union of two cells, and the mixture of their contents, do not always take place. Sometimes a cell produces a germ-cell from its own contents, when it either forms no conjugative branch, or when this does not meet with another with which it can become united. In the latter case the contents separate from the interior of the wall, and move toward the blind prolongation. Arrived there, any further advance being prevented, they become transformed into a cell, and indeed exactly of the form which they possess at this time: this happens in *Zygnema stellinum* (pl. II, fig. 4). Sometimes it happens that two cells communicate by a connecting tube, but the contents of the two cells do not become united. Then two germ-cells originate, one of which is ellipsoidal or globular, while the other exhibits the form possessed by the contents, which had already begun to move before they came to a state of rest and cell-formation (pl. II, fig. 6, in *Zygnema stellinum*). In both the cases here described, it must inevitably be assumed that the membrane originates on the surface of the contents. If these cells were formed of minute size in the interior, they must, in their ulterior development, retain their original globular or ellipsoidal shape, like all cells which originate and become developed in a free condition.

Schleiden* is inclined to attribute a different mode of origin to the germ-cells of *Spirogyra*, as he says: "In the already irregularly agglomerated cell-contents, I almost always found a delicate cell, which I cannot but regard as the true spore, around which the green and granular mass is merely applied, forming a false membrane around it, or which gradually absorbs this mass into its interior. Perhaps the . . . . . . Cytoblast . . . . . .

* Grundzüge der wiss. Botanik, ii, p. 31 (first edition).

is the producer of the proper spore-cell." I suspect that Schleiden has observed a peculiar and enigmatical cell- or utricle-formation, which occurs in *Spirogyra*, and of which I shall hereafter take especial notice. This cell is neither the rudiment of a germ-cell, nor the germ-cell itself, nor is it produced from the nucleus of the cell. It appears to me that the cell-nuclei which lie in the centre of the cells of *Spirogyra* do not play any important part in the origin of the cell. They are often visible until the cell-contents accumulate into a ball, then they disappear; but they are by no means hidden in the contents, since if they are still visible in the later stages, they are on the surface of the green contents. I have therefore no doubt that the nucleus of the parent-cell becomes dissolved before the contents are transformed into a germ-cell. Besides, it is not evident what *two* nuclei should do in the formation of *one* cell, each conjugating cell having one nucleus. In pl. II, fig. 5, some cells of *Spirogyra quinina* are figured, in which germ-cells are formed without conjugation. In two of them the nucleus is seen on the surface of the contents; in the third it has disappeared.

I mentioned also another free cell-formation, without visible nucleus, where the observation in like manner affords a tolerably certain conclusion. This is the origin of the sporangia in *Achlya prolifera.* I have already alluded to this point in the first part of this essay,* in reference to the so-called division of cells. *Achlya* furnishes remarkable facts, both on parietal and free cell-formation, so that I will give some figures of it. In the clavately swollen ends of a branch are formed usually one, more rarely two or three sporangia. If there be two or three (Pl. III, figs. 5 and 6), these originate by free cell-formation; if there be merely one, it originates sometimes through free (fig. 3), sometimes through parietal, cell-formation (fig. 7). When the sporangia originate by free

* Ray Society's Translation, p. 279.

cell-formation, the first process is the formation of one or more heaps of mucilage-granules, according as one or more cells are to be produced. At first these heaps have no definite boundary, but pass insensibly into the remaining mucilaginous contents of the cell. Subsequently the outline becomes more sharply defined, they are surrounded by ray-like circulation-filaments (fig. 1). The outline becomes still sharper, and then but a few filaments remain (fig. 2). At length the surface of the heaps of granules becomes smooth, and now an inclosing membrane gradually makes its appearance (fig. 3). Has this membrane originated on the periphery of the granular accumulation, or has it been formed in its interior as a minute cell, and in growth gradually absorbed its contents from without? I am compelled to regard the former view as correct, because nothing can be seen of the latter process, even in very transparent heaps of granules. That the membrane originates on the surface of the subsequently inclosed contents is in the highest degree probable, from the analogy with the parietal cell-formation in the same plant; for while a free sporangium is forming in the interior of one clavate branch, in others the whole clavate extremity becomes a sporangium (fig. 7). Here the cell is not formed in the interior as a little free cell, but its walls originate in the very place where they first become visible. Now the two facts support each other, and in such a way that, taken together, they prove the origin of the membrane on the surface of the contents. That in the apparent formation of a mere septum, a perfect cell actually originates, lying in contact with the wall of the branch (not a mere wall), is shown by the analogy with the second case, where a perfect sporangial cell is formed at some distance from the wall of the branch. That in free cell-formation the membrane originates on the surface of the contents (not in the interior of them, around a nucleus, or in any other way), is shown by the analogy with the first case, where the cell-membrane is formed in like manner on the periphery of the contents. The dis-

tinction lies solely in this: that in the first case the whole contents of the extremity of the branch, in the second only a part of them, are converted into a cell.*

b. With a parietal nucleus.

Free cell-formation with a visible nucleus I have hitherto only observed with certainty in the embryo-sac of the Phanerogamia. The cell-formation in the pollen-tube is not yet clear to me; of those cells which form the embryo and the suspensor, I rather imagine that they originate through parietal cell-formation; of those cells which Schleiden explains as transitory cells, I am still doubtful whether they are actual cells, or not rather mere nuclei.

When the formation of the endosperm-cells takes place in the embryo-sac, the fluid contains the following structures:

1. Cells with granular contents, and a perfect nucleus, with evident nucleoli.
2. Mucilage-granules.
3. Perfect nuclei, with evident nucleoli.
4. Minute homogeneous globules of mucilage.
5. Larger homogeneous globules of mucilage, with a globular cavity.
6. Larger homogeneous globules of mucilage, with a smaller concentric or excentric ring.

* In the sporangium which has originated in the above ways, two kinds of cells may be formed, either larger, immoveable, globular spores, with a tough membrane, or smaller oval cellules, with a delicate membrane, which move about actively either already inside the parent-cell or, and especially, after they have been set free. To this end the sporangium grows out into one or more processes (figs. 4, 6, 8), which open at the point and allow the cellules to escape. I formerly believed that even a third kind of cell originated in the sporangium, namely, smaller cells with delicate walls like the moving cellules, but exhibiting no motion, and capable of germination. Whether this third kind actually exists, or whether they are identical with the moving cells, and again, whether these are capable of germination, I must leave open, since the latter has been stated to be the fact by several observers, till further researches have been made.

7. Mucilage-globules, of equal size with the preceding, partly homogeneous, partly very slightly granular, with a cavity and a nucleolus contained in it.

8. Like 7; but with several cavities, and as many nucleoli.

9. Like 7, with one or more solid nucleoli, and no cavity.

10. Larger homogeneous or slightly granular mucilage globules, of clearer, more transparent substance, with or without cavities, with or without nucleoli.

11. Clear vesicles, of the size of 10, with or without nucleoli.

12. Mucilage-globules, like 10, or utricles, like 11, surrounded by a thin layer of homogeneous mucilage, which is usually thinner on one side than on the opposite.

13. Like 12; the mucilaginous layer has considerably increased in size on one side, become somewhat granular, and displays a very indistinct membrane on its periphery

14. Like 1, namely, distinctly perfect cells, with perfect nuclei and distinct nucleoli.

These are the principal and most frequent forms of organization that are found in the fluid of the embryo-sac, and which are of importance in the processes which go on. A quantity of intermediate stages between the various forms here enumerated are rather calculated to confuse the vision and judgment than to make a process clear through a complete history of the gradual development. Observation of these matters has to strive against two obstacles, which appear to me almost insurmountable: one depending on the fact that partial changes ensue very rapidly in the solid portions of the contents, especially when water is applied; the other, that the different stages of development are all mixed together, and thus, without the help of extraneous characters, are necessarily judged of merely by their own individual aspect.

Schleiden, it is well known, has interpreted the phenomena in this way: that a number of mucilage-granules become confluent to form nucleoli; that the nucleoli

become conglomerated with other mucilage-granules, so as to produce a nucleus, and that around the nucleus is formed a membrane, which retreats from the nucleus on one side through the absorption of fluid.

Now as to the *mucilage-granules*, which lie in the effused fluid, I believe that they are derived, in great part, from the destroyed endosperm-cells, and that they do not at all contribute to the formation of the nuclei. In the embryo-sac, where cell-formation is commencing, I often find but little, often no granular contents; these increase with the fuller development of the endosperm-cells, and with the cessation of cell-formation. This circumstance already makes the origin of the nuclei from mucilage-granules very improbable.

Again, I was never able to observe a confluence or conglomeration of mucilage-granules, and the production of a nucleus therefrom. The solid portion of the cell-contents certainly concreted into larger or smaller masses, especially when water was added. Sometimes only a few mucilage-granules, sometimes mucilage-granules and nuclei, sometimes large portions of the firm granular contents became united; a homogeneous mucilage was always the connecting medium. This, however, does not happen through any organic process, but because the mucilage coagulates. The conglomerated masses do indeed exhibit, like all coagulating mucilage, a definite outline, and, when they are small, sometimes present a striking resemblance to nuclei or young cells. But they are often actually seen to be formed, in the same way that they have been formed here, when the mucilage of any cell flows out into water.

Besides the mucilage-granules, we must likewise leave out of consideration, in cell-formation, the *clear vesicles*, which might easily be taken for nascent cells, but which are found in almost all homogeneous and rather fluid mucilage. They appear to me to be minute drops of some watery fluid (water?), which have separated from thicker, mucilaginous fluid of the cell. In most cases the

mucilage exhibits an equal density up to the border of the drop of water, so that where the water commences the mucilage appears as if cut off from it. Sometimes it is denser at the borders of the drop of water, and seems to form a proper membrane around it. Probably this is the consequence of a lengthened action of the water upon the mucilage. In any case the watery vesicles go no further; certainly undergo no organic changes.

All *perfect nuclei* lying in the fluid must also be excluded in the consideration of cell-formation. They are wholly absent at first, and multiply in proportion to the number of fully-developed endosperm-cells contained in the embryo-sac. They are the nuclei of these cells, and become free, with the granular contents, through their destruction. These nuclei are very apt to lead the observer astray, since they are not capable of the subsequent stages of development.

Small, globular drops of perfectly homogeneous mucilage, with defined outline, are absolutely constant phenomena in the process of cell-formation in the embryo-sac. They vary from ·001-·004 of a line, and are distinguished from the mucilage-granules, even in the earliest condition, by a perfectly globular form and smooth surface. The mucilage-globules are never absent; they always constitute the first stage of cell-formation (pl. II, fig. 7, *a*, *b*, *c*; 8, *a*). They exactly resemble the mucilage-globules which represent the nascent germ-cells in *Valonia* and other Algæ, in Lichens and Fungi.

A more advanced stage is represented by the *larger mucilage-globules, in which a smallish ring is inclosed, while the whole globule possesses an uniform consistence* (fig. 7, *d*, *e*, *f*). The inclosed ring may appear *clearer* (fig. 9, *a*) or *denser* (fig. 9, *b*) than the outer part of the globule. There can be no doubt, and the further development also confirms it, that the mucilage-globule is a cell-nucleus, the inclosed ring a nucleolus. How have the nucleus and nucleolus originated? This is a question which I cannot answer from direct observation on cell-

formation in the embryo-sac. Other grounds, however, which exist in the phenomena exhibited in the propagation of the nuclei, render it probable, in my opinion, that the nucleolus originates first, and the nucleus subsequently, around it.* In that case, those little homogeneous mucilage-globules, first visible, would have to be regarded as the nucleoli.

At this stage of development we find, as a rule, a homogeneous nucleus inclosing a homogeneous nucleolus. *Through injurious external influence, a hollow space round the nucleolus is produced.* This change occurs during the examination. Fig. 9 represents such a nucleus, immediately after the fluid of the embryo-sac had been brought under the microscope. It soon acquired the aspect *d* (fig. 9). This appearance of a hollow space round the nucleolus is observed both when the fluid of the cell is diluted by the addition of water, and when it is brought on the stage without water, and becomes denser through evaporation. The cause of this phenomenon appears to me to lie in the fact, that through the action of the *slightest* possible unfavorable influence from without, the mucilage of the nucleus, as well as that of the nucleolus contracts, and they are thus separated from each other. If the action be at all strong, the nucleus and nucleolus contract into a dense, solid body. Care must therefore be taken not to mistake abnormally altered nuclei, such as are drawn in fig. 9, *d*, for cells with nucleus and nucleolus, with which they may very readily be confounded.

Other nuclei contain two, three, or four nucleoli (fig. 7, *g*; fig. 8, *c*; fig. 9, *e*). These nucleoli are also sometimes of the same consistence as the nucleus, sometimes they are denser, at others not so dense. In abnormal alteration of the nuclei, a hollow space presents itself to notice around each individual nucleolus. Fig. 9, *e* and *f*, represent such a nucleus before and after alteration.

* See the Essay on the Utricular Structures in the Contents of the Vegetable Cell.

These forms with two, three, or four nucleoli *seem* to prove that the nucleus generally originates before the nucleoli. Since no distinction is evident in the nucleoli, one is inclined to regard them all of equal value; and since some of these nucleoli certainly originated after the nucleus, one is led to assume the same of all. I believe, however, the assumption that *one* of these nucleoli originated before the nucleus and produced it, and that the rest were formed subsequently, may be warranted by the analogy with cells. In cells also we sometimes find several nuclei, a primary and one or two secondary nuclei.* Therefore, since both the life of the nucleus with the life of the cell, and the relation of the nucleolus to the nucleus with that of the nucleus to the cell, exhibit so great analogy, we may reasonably assume, that when a nucleus contains several nucleoli, one of them is the primary, which originated prior to the nucleus, while the rest are secondary nucleoli formed within the nucleus.

The nuclei have now attained a definite magnitude. Their membrane may sometimes be seen indistinctly on their periphery. Their mucilaginous contents are either homogeneous or very slightly granular, of variable density. The substance of the nucleoli is generally denser than that of the nuclei, sometimes of equal, at others of a less, degree of density, so that in the last case the nucleoli appear as clearer spaces in the denser contents of the nuclear vesicle.

Subsequent stages exhibit *nuclei,* like those just described, *with a thin layer of homogeneous mucilage.* This layer is usually much thinner on one side than on the opposite (fig. 8, *d*). More rarely it is equally thick on all sides; which may be ascertained from the fact, that, in rolling, the nucleus always retains its central position (fig. 8, *e*). The mucilage is perfectly homogeneous, distinctly defined externally, and bounded by a somewhat darker line. As yet I can discover no membrane. The mucilage

* See Part I of this Essay. Ray Society's Translation, pp. 242 et seq., and pp. 247 et seq.

is mostly somewhat more dense than the substance of the nucleus; sometimes it is brighter than the latter.

The mucilage surrounding the nucleus now continually increases in quantity; the nucleus is always distinctly visible, situated at the periphery (fig. 8, *f*). There are, however, isolated exceptional cases here, where the nucleus is free, and more or less removed from the circumference.

The mucilage then becomes evidently granular, and a distinct membrane is to be made out upon its surface (fig. 8, *g*). The latter frequently becomes visible even when the contents are still homogeneous. In this stage, as in the preceding, the nucleus is mostly less dense than the surrounding mucilage, and therefore appears like a clearer space. The cell is now visibly formed. Whether the membrane first originates at the time it becomes visible, or had originated at a still earlier period, can scarcely be ascertained by observation. The latter appears to me probable.

According to Schleiden, the cell-membrane originates immediately on the surface of the nucleus; it absorbs watery fluid by endosmose, and expands; the nucleus remains attached on one side of the cell; the cell is a fine, transparent vesicle; its contents a watery fluid, and appear merely as a hollow space between the nucleus and the granular mucilage of the embryo-sac, which is pushed backward by its expansion.* Schleiden adds, that the cells become wholly dissolved in a few minutes in distilled water, so that only the nuclei remain. I confess that I have never seen such very clear and transparent cells. In most cases I find the contents of the cells more dense and darker than those of the nucleus; rarely clearer, but even then always either homogeneously mucilaginous or finely granular. In like manner, I did indeed see various effects on the young cells and their contents produced by the action of water, but never a solution.

* Müller's Archiv, 1838. [Schleiden has changed this opinion in the latest edition of his 'Principles of Botany' 1849). See Appendix to Dr. Lankester's Translation.—A. H.]

I will here mention another phenomenon which I observed a few times. I do not think that Schleiden has allowed himself to be deceived by this; yet others, who may also observe it, may easily suppose it to be the process of cell-formation as described by Schleiden, to which it bears great resemblance. Nuclei which have attained a considerable size, absorb water by endosmose. The membrane of the nucleus detaches itself on one side from the contents, the interspace becoming filled with water. The comparison with a watch-glass is here not inapt. In some cases, the membrane continues to expand, suddenly bursts, and disappears. In others, this expansion goes on to a variable extent, and ceases when the force of the endosmose and the elasticity of the membrane come into equilibrium. The membrane remains visible and is not dissolved. (See fig. 9, *i, k, l, m*; in *h, i, k* the same nucleus is represented previous to the action of the water, and in two stages after the operation of endosmose has begun.)

If the nuclei contain only one nucleolus, one may readily suppose them to be cells, and the hollow space round the nucleolus to be the nuclear vesicle (fig. 9, *i, k*). Those forms, with two or three nucleoli (fig. 9, *l*), however, prove that it is inside the nuclei that the hollow spaces have been formed through the action of water, as is the case in the nucleus represented in fig. 9, *c-g*. The contents of the nucleus are pretty sharply defined where they join the water. The outer circumference of the nucleus exhibits a dark line, which is formed by the delicate membrane lying close upon the contents, and which, therefore, is lost when this membrane has become detached from the contents (fig. 9, *k, l, o*). These facts furnish a new proof that the nuclei possess a membrane and are vesicles.

The young cell appears at first as a layer of mucilage surrounding the nucleus. Subsequently a membrane becomes visible on the surface of the mucilage. Consequently the cell is at first, besides the nucleus, quite filled

with mucilage. When the cell expands more, it becomes hollow in the interior. The mucilage remains on the wall as a thin layer, and forms a coating over the whole internal surface. This is the *mucilaginous layer* which I have described in the Algæ,* and which Mohl † has named the "*primordial utricle,*" regarding it as a structure proper to all cells. The mucilaginous layer is usually thicker at the place where the nucleus of the cell lies, than over the rest of the wall. Not unfrequently the nucleus lies wholly imbedded in the mucilaginous layer. Schleiden thought that it was inclosed in a duplicature of the cell-wall. But this is certainly incorrect, and is best refuted by the fact, that the nucleus may become detached, with the mucilaginous layer, from the membrane of the cell.

Mohl conjectures that the first thing formed around a nucleus is the primordial utricle, and that the membrane does not originate until after this. The statements in regard to this are, however, too vague, and made without consideration of cell-formation in the embryo-sac, so that no minute discussion is necessary for the criticism of the phenomena in question. I merely remark that I see the origin of the mucilaginous layer (primordial utricle) on the internal surface of the cell in the endosperm-cells, in the same manner as in all other cells where new contents are formed. The mucilage at first fills the whole cavity of the cell, and subsequently merely lines the walls as a thin layer. The mucilaginous layer is, therefore, a *secondary* phenomena in the *origin of the cell-contents.*

c. Of free cell-formation as a general law.

Now that I have separately brought forward the facts which are at my command respecting free cell-formation, I will briefly collect and compare them, in order to

* See Part I of this Essay. Ray Translation, p. 268.

† Botan. Zeit. 1844. (Translation in Taylor's Scientific Memoirs, vol. iv, p. 91.)

deduce a general law, and, in addition, to point out some essential differences within the bounds of this law.

The phenomena which accompany free cell-formation may be seen with the greatest certainty in the origin of the germ-cells of *Zygnema*, the sporangial cells of *Achlya*, and the larger cells produced by abnormal formation in *Bryopsis*, *Conferva*, and other Algæ. Here a portion (in *Zygnema* the whole) of the contents becomes isolated, acquires a globular or ellipsoidal form, and produces a perfect closed membrane all over its external surface. In the prevalent opinion on free cell-formation, it has been hitherto assumed that the membrane originates around a nucleus. In the cases mentioned here there cannot be any doubt that the membrane originates around the contents. It was further assumed that the membrane was formed first and the contents subsequently. Here, however, the contents are decidedly primary and the membrane secondary.

The mode of origin of the endosperm-cells in the embryo-sac comes next to these facts. Observation shows here, first a nucleus, then a layer of mucilage which surrounds this nucleus, lastly, a distinct membrane which incloses the mucilage together with the nucleus. The phenomena accessible to observation leave the place and epoch at which the membrane originates undecided. The assumption that it is formed immediately around the nucleus is, therefore, still within the bounds of possibility. But it would appear to me uncalled for and superfluous, since no fact nor analogy are in its favour.* If we assume, on the other hand, that a definite quantity of mucilage collects around the nucleus, and that the cell-membrane originates around this mucilage, the assumption on the one hand fully meets the appearances in the

* Schleiden's observations certainly are contradictory to my representation and interpretation, and these points are still open. Formerly I thought that I also saw cell-formation round the nucleus. I have studied the processes occurring in the embryo-sac repeatedly, for several years, and in different plants; with more accurate observation, however, I can no longer find any condition which perfectly agrees with Schleiden's representations.

case in question; and on the other, connects itself, through analogy, with other facts, as in the cell-formation already mentioned, in *Achlya*, *Zygnema*, and other Algæ, as well as with the parietal cell-formation, where the membrane is likewise produced on the surface of the contents.

The third type of free cell-formation still remains, in the origin of a number of germ-cells of Algæ, Fungi, and Lichens. Here observation at first discloses to us extremely small globular masses of mucilage. They become larger, granular, and at last an inclosing membrane may be made out. Actual experience is again insufficient to furnish a certain determination of the question when and how the membrane originates. It seems to me safest to take the simple explanation of the facts which is first suggested by what we see, especially since they can in this manner be most readily brought into agreement with the other facts. I therefore assume here, that the membrane is formed round a collection of the mucilaginous contents. Whether this happens earlier or later, seems to be all one; but it is probable that the membrane actually exists some time before it is distinctly visible. The observations on free cell-formation therefore *require*, they partly *allow*, the assumption, that the *membrane is produced on the surface of the contents*. This hypothesis must, since no facts and no analogy are opposed to it, hold as a universal law. The *contents*, therefore, are *primary*, in the cell, the *membrane* is only *secondary*.

In the production of the endosperm-cells a nucleus exists. The nucleus originates first. Subsequently, a layer of mucilage accumulates on its surface. Probably it is the attractive force of the nucleus which draws to it a portion of the contents of the parent-cell. That the nucleus does possess such a power is known from many facts. In almost all cells in which a nucleus exists, a portion of the contents of the cell become collected on its surface. Consequently, we may define cell-formation in the embryo-sac in the following way:—*A nucleus origi-*

8

nates, which attracts a small portion of the mucilaginous contents, and becomes wholly clothed by it: on the surface of the mucilaginous layer the cell-membrane originates.

In the other cases of free cell-formation, nothing can be seen of nuclei during the whole process. Either no nucleus really exists, or it withdraws itself from vision, through relatively minute size, or agreement of density with the density of the contents of the young cell. In the first case we must assume, that a definite portion of the contents of the parent-cell may independently become individualized and converted into a cell. In the second case, the process would be the same as in the endosperm-cells. In my opinion a rigid distinction must be made between normal and abnormal cell-formation, in solving this question. By normal cell-formation I understand such as is necessarily connected with the vegetative and reproductive processes in a plant, and which always proceeds according to laws definitely laid down for each plant. By abnormal cell-formation, on the other hand, I understand such as is not directly and necessarily connected with the vegetative and reproductive processes, and must always be regarded more or less as produced by the action of external influences interrupting the regular course of the life of the cell.

As to the abnormal cell-formation in the cells of Algæ, I am convinced that no nuclei ever take part in it. For this kind of cell-formation is united by every possible intermediate stage, with a process in which the formation of nuclei cannot enter into the question. In the first part of this Essay* I have mentioned a partial formation of membrane where, in consequence of disturbing external influences, the mucilaginous layer is retracted in places from the cell-wall, and becomes coated with new pieces of membrane. This process is of course independent of the influence of any nucleus. I, at the same time, stated that the mucilaginous layer sometimes becomes detached

* Ray Translation, pp. 268 et seq.

over large surfaces, or even entirely (as in *Bangia*) from the cell-wall, and produces a membrane on its surface; moreover, that sometimes the mucilaginous layer divides into separate portions, and produces several perfect cells. It is clear that in this case, again, we cannot think of the formation of a nucleus for the production of the cells. These facts stand in direct connexion with those above described in abnormal free cell-formation. The mucilaginous layer separates from the wall, divides, and forms several larger or smaller cells. These vary in size and contents, from large cells containing chlorophyll and starch, to the most minute cells inclosing merely homogeneous mucilage. This mode of cell-formation varies, besides, from that condition in which the whole cell-contents partly form new cells, the remainder being dissolved, to that in which merely a small portion of the contents forms one or more small cells, while the remainder is unaltered. These transitions show that all the phenomena of abnormal cell-formation are related to *one* law, and that since the formation of nuclei is inadmissible in some cases, it must not be assumed in the rest.

In those cases where free cell-formation takes place normally, as in the origin of the germ-cells in Algæ, Lichens, and Fungi, and of the sporangium in *Achlya*, we can see nothing of a nucleus. The fact, as presented directly to us, with the assistance of the amplifications our present optical instruments effect, may in the same way be most simply explained thus: that larger or smaller portions of the contents at once become individualized, and acquire a membranous investment. But the circumstance that a nucleus may sometimes be perceived subsequently, in the germ-cells which have originated by free cell-formation, seems to me to speak against this. I have seen it in *Erysibe*, *Achlya*, *Peziza*, *Coleochæte*, &c.; and it appears to me to be also present in the germination of the Zygnemaceæ. Two explanations may be given as to this nucleus. Either it is a *primary* nucleus, around which the cell originated, or it is a *secondary* nucleus

which has been formed as an after-growth in the cell. We are acquainted with such secondary nuclei in the parent-cells of spores and pollen-granules, and in the spore- and pollen-cells themselves.* In these, however, there is also a primary nucleus. The two nuclei lie side by side in their cell; or the primary nucleus becomes dissolved when the secondary is produced. In the cases referred to, the primary nucleus is parietal, the secondary free. Now, as regards the nuclei in the germ-cells of the Algæ, Lichens, and Fungi, in some I found a distinctly parietal position. I conjecture, therefore, already on these grounds, that they are primary nuclei, and, consequently, that a nucleus exists in the origin of the germ-cells. This conjecture is supported by another reason. In the section on the nucleus,† I demonstrated that if any conclusion from analogy at all be permitted, it must be assumed that every vegetable-cell possesses a nucleus, at least in the early stages of its existence. It is, therefore, in the highest degree probable that a nucleus is present in the cell originating by normal cell-formation, and this at the actual time of its origin. This argument is still further borne out by the fact that sometimes, in plants where no nucleus is visible in the formation of the germ-cells, all the succeeding cells are developed under the influence of nuclei. Now it seems to me very improbable here that the vegetative cell-formation should take place through nuclei, and the reproductive cell-formation without, that, consequently, the lower cell-formation should present greater complexity, and the higher be the more simple. It is further to be remarked, that the assumption that germ-cells originate like endosperm-cells around nuclei, may be connected with the visible phenomena without stretching any point. In both places, globules of mucilage first present themselves, which gradually enlarge, and at last appear as granular cells. In the endosperm-cells, the nuclei may be distinguished and recognised as such,

* Part I, Ray Translation, p. 247. ‡ Ibid., pp. 219 et seq., and 246.

at a very early period. In the germ-cells, the nuclei are distinct, as such, sometimes never, sometimes only in the fully-developed condition of the cell. Since the nuclei can be distinguished sufficiently early in the endosperm-cells, it is also possible to observe their relation to cell-formation. Since the nuclei of the germ-cells cannot be distinguished until a late period, their relation to cell-formation cannot be made out by direct observation. This is the more conceivable, that the endosperm-cells are many times larger than the germ-cells, and their nuclei than nuclei of the latter. Besides this, endosperm-cells do also occur in which the presence of a nucleus, and its cooperation in the cell-formation, cannot be distinctly seen. This is especially the case when the contents of the nucleus and those of the young cell are homogeneous and of equal density. What I have stated is, I think, sufficient reason why the apparent want of nuclei in the free formation of germ-cells cannot be maintained as a proof of an actual absence of these bodies.

Normal free cell-formation thus comprehends, according to my views, the following essential and regular periods: *A nucleus originates in the contents of the parent-cell. This accumulates on its surface, by attraction, a greater or smaller quantity of the contents of the parent-cell, which, at least at the periphery, consist of homogeneous mucilage. This portion of the contents becomes coated by a membrane over its entire surface.*

The variations which occur within the limits of this identity, refer either to the nature of the portions of contents which become individualized, or the relation of the secondary cells to the parent-cell. The portion of contents which become isolated, exhibit *chemical* and *morphological variations*. They are composed either of homogeneous, colourless mucilage; of homogeneous colourless mucilage mingled with colouring matters; of granular mucilage, or granular mucilage mixed with colouring granules and starch-globules.

The relation of the secondary cells to the parent-cell

depends either on the *share which the parent-cell bears in the production of the secondary cells, or on the physiological similarity or dissimilarity which exist between the parent-cell and the secondary cells.* In reference to the first point, it is of importance whether the *whole contents of the parent-cell, or only larger or smaller portions of the contents, are converted into secondary cells,* and in what *number* these are produced in the parent-cell. In reference to the second point, either perfectly similar or dissimilar secondary cells may be formed in the parent-cell. Physiologically similar secondary cells are produced in *Hæmatococcus* and *Chlorococcus;* all other cells originating through free cell-formation, are more or less different in physiological respects from the parent-cell.

The question still remains, to what extent is free cell-formation met with in the vegetable kingdom? In the first part of this essay,* I limited parietal cell-formation to several families of Algæ, and the special parent-cells of the four-spored Cryptogamia and the Phanerogamia. For all the examples there enumerated, I had observations which more or less bore out the statement. Free cell-formation, on the other hand, I was acquainted with in the endosperm-cells and in the germ-cells of Algæ, Fungi, and Lichens. For all other cases, especially for all vegetative cells of four-spored Cryptogamia and the Phanerogamia, the decision depended partly on analogy, partly on some observations of Schleiden's, and of my own. I therefore concluded:—In parietal cell-formation the nucleus is, as a rule, central; in the free cell-formation in the embryo sac, the nucleus is lateral. It is probable from this, since the cells of the higher Cryptogamia and the Phanerogamia possess a lateral nucleus, that they originate by free cell-formation. The secondary cells were, moreover, figured actually free within the parent-cell, in certain cases, by Schleiden and by myself. I was satisfied, therefore, that the cells with lateral nuclei originated free.

Observation and reflection have since led me to a

* Ray Trans., p. 292.

different conclusion. In the very first place comes the question, what import may be attributed to those observations which represent the secondary cells free within the parent-cells, as Schleiden's in the germinating spore of *Marchantia,** in the hairs of the ovary of *Lupinus,*† in the terminal shoot of *Opuntia,*‡ in the pollen-tube, and in other cells,§ and my own in the apex of the root of *Lilium.*‖ As to my own earlier investigations, they belong to an epoch (autumn 1841, and spring 1842,) when I was yet unacquainted with the mucilaginous layer. When I discovered it, in the summer of 1842, at Naples, in Algæ and Florideæ, and subsequently refound it in other vegetable-cells, I soon became convinced that my earlier researches were doubtful, since that which I had held to be the cell-membrane might in every case have been the mucilaginous layer.

With regard to the facts published by Schleiden, I likewise believe that the explanation given by him is by no means placed beyond all doubt. In the first place, cell-formation in the pollen-tube cannot prove anything for other cell-formation; since here two thoroughly different kinds of cell-formation, one of which is transitory while the other produces the embryo, have not yet been nearly sufficiently discriminated. The cell-formation in the spore of *Marchantia,* I must, from certain researches of my own on the germination of the Hepaticæ, hold to be incorrect; and conjecture that a confusion has occurred with the accidental formation of utricles, such as sometimes happens in cells. With respect to the rest of the observations published by Schleiden, it must be borne in mind that he also makes no distinction between cell-membrane and mucilaginous layer; so that the interpretation is always possible, that the apparently free secondary

* Müller's Archiv, 1838, Tab. iii, figs. 19, 20.

† Acta Ac. C. L. C. Nat. Cur., vol. xix, p. 1, pl. x, fig. 38 *e*.

‡ Mém. de l'Acad. Imp. d. Sc. de St. Pétersbourg, VI Serie, vol. iv, pl. viii, fig. 9.

§ Grundz. 2d Ed. pl. i, figs. 12 and 16.

‖ Linnæa, 1842, Pl. ix, figs. 30, 31.

cells have been merely the *contents* of secondary cells contracted through external influences. Two reasons especially strengthen this opinion in my mind. In one case Schleiden figures three secondary cells in one parent-cell. Now, as I shall hereafter show, it is an universal law that in the formation of the cells of tissues only two secondary cells are formed in each parent-cell. If, then, one wall have been overlooked in consequence of the alteration of the contents, so readily may the other. Schleiden further says that he has often seen two cells inside one cell,* especially after the *application of nitric acid.* This is in contradiction with the observation he made, that the young cell-membranes are wholly dissolved in distilled water, in a very short time.† If this will happen in water, it will certainly happen much more quickly in nitric acid. It is in the highest degree probable from this, that Schleiden saw merely the contracted *contents,* not the young cell and its membrane; and, moreover, in that condition in which the action of the acid has already made the delicate membrane of the secondary cells indistinct, while the older and firmer membrane of the parent-cell still remains visible.

Since then a better appreciation of the membrane, and the recognition of the mucilaginous layer, rendered all earlier observations uncertain, I instituted a new series of investigations. If the tissue of the higher plants were really produced by free cell-formation, this could only be proved by seeing the young free cells, free in uninjured and unaltered parent-cells. I must confess that I never have arrived at this. In most cases this is, indeed, no proof at all of the contrary; since admitting a free cell-formation, it would, in my opinion, be unlikely, in the majority of cases, that the delicate membranes should be seen in the but slightly transparent mucilage, previously to their union to form a wall. On the other hand, I believe that in certain other instances it might possibly have

* Grundz. 2d Ed. p. 202. † Müller's Archiv., 1838, p. 145.

happened, that the young free cells should have been seen, —in some when the parent-cells were larger, and filled with granular contents (as in many hairs when their development is beginning, e. g. of *Tradescantia*); in some when the parent-cells, of considerable size, contained a homogeneous and tolerably transparent fluid (as in the young rind and bark of many plants); in others when the parent-cells were tolerably large, and more or less filled with coloured, homogeneous or granular contents (as in *Callithamniaceæ*). But in no case could I see the young free cells inside the parent-cells. The formation of the cells of tissues in the higher Cryptogamia and the Phanerogamia, displayed to me nothing but either merely a dividing wall, or two nuclei and then a wall between them, or a larger nucleus which divided into two nuclei, and then a septum formed between these.

In consequence of these researches I have come to the conclusion, that all vegetative cell-formation is parietal. This conclusion is supported on the one hand by the facts observed, on the other by analogy. Among the facts, some do not contribute to the proof; others make the parietal cell-formation probable; a few can be explained by it alone. In *Griffithsia corallina** (pl. III, fig. 9), the parent-cells are very large, as much as ·080 of a line long and more, and sometimes of almost half that breadth. The granular contents lie upon the wall; the interior is filled with clear, colourless fluid. The cell divides into two unequal cells, at the apex, by a cross wall (fig. 10): an upper cell, small, disc-shaped, and wholly filled with granular contents (*a*), and a large lower cell (*b*), resembling the parent-cell in all its parts. If the two secondary cells were formed free, the lower, especially, must be seen during its development, and changes in the parietal firm contents be perceived, when this became dissolved in the parent-cell and reorganized in the secon-

* *Griffithsia* belongs to the *Florideæ*; the *Florideæ*, however, have not a natural relationship to the Algæ, but with the Hepaticæ and Mosses. They also, like these, possess parietal nuclei in the cells.

dary cell. The appearances are the same here as in the parietal cell-formation of the Algæ. From this indubitable example we have numberless intermediate stages to those cases in which no evidence is afforded, either for or against. The succession of states and the transitions show, however, that the same explanation must come into application for all cases.

The conclusion that all vegetative cell-formation is parietal, is also supported by analogy. The parietal cell-formation of Algæ and special parent-cells occurs, as a rule, with central nuclei. But to this rule there are some exceptions, when the parietally originating cells possess a lateral nucleus.* In the vegetative cell-formation of the higher Cryptogamia and the Phanerogamia, the nucleus is, as a rule, lateral; yet it appears to me that, in exceptional cases, it may be free also. The appearances in the Algæ and special parent-cells on the one hand, and in the cells of other plants on the other, are essentially the same, only they present themselves much more distinctly in the first, and much more definitely require to be explained as parietal cell-formation.

Parietal and free cell-formation would, according to my views, extend through the vegetable kingdom within the following bounds:

Parietal: the vegetative cell-formation of all plants, further, the reproductive cell-formation of many Algæ and Fungi. Free: the reproductive cell-formation of most (not all) *plants,* namely, the *germ-cell formation of many Fungi, many Algæ, and of the Lichens; the formation of the spores inside the special parent-cells in the four-spored Cryptogamia (?), the formation of the pollen-cells inside the special parent-cells in the Phanerogamia (?), and the formation of the endosperm-cells in the Phanerogamia.*

The cells which have originated by parietal cell-formation possess central nuclei (in most Algæ, and generally the special parent-cells), *or lateral nuclei* (in most Fungi,

* Part I, Ray Trans., p. 552 et seq.

in the Cryptogamia from the *Florideæ* upward, and in the Phanerogamia). *The cells which have originated by free cell-formation contain, as a rule, a lateral nucleus, rarely a central nucleus* (the germ-cells of certain Algæ).

V.—ON CELL-FORMATION IN GENERAL.

Now that I have discussed, in the third section of this essay, *parietal*, and, in the fourth, *free* cell-formation, I will compare these two processes, and thence deduce a general law.

In *parietal* cell-formation *the contents of the parent-cell divide into two or more portions. Around each of these portions of cell-contents a perfect membrane is produced, which, at the moment of its origin, is in contact partly with the wall of the parent-cell, partly with the corresponding wall of its fellow secondary cell or cells.*

In *free* cell-formation *a greater or smaller portion of the contents becomes isolated, or even the whole contents of the cell. On the surface of this is formed a complete membrane, altogether free at its outer surface* (in contact neither with the wall of the parent-cell nor those of its fellow secondary cells.

Cell-formation includes two stages; the first is the *isolation* or *individualization of a portion of the contents of the parent-cell;* the second consists in the *origin of a membrane around individualized portions of the contents.* Cell-formation commences with the first, and is completed in the second stage. The complete individualization only occurs for the express purpose of *cell-formation.* The *formation of membrane,* on the contrary, is a universal phenomenon, proper to the cell generally (not merely at the moment of its origin). I will first speak of this latter.

In the first half of this memoir, speaking of the cells of the Algæ, I have noticed the mucilaginous layer which lies on the outermost boundary of the contents, and therefore close upon the surface of the cell-wall. According

to Mohl, this is of very general occurrence. From my own researches, I believe that I may venture to affirm, that, with the exception of those young cells, in which the cavity is filled with homogeneous mucilage, *the mucilaginous layer is always present in cells so long as they retain their vitality.* It is well known that the thickening of the cell-walls is effected by a deposition of new layers. These new layers are produced between the cell-wall and the mucilaginous layer. This fact admits of no other explanation than this : *that the mucilaginous layer* (or the contents through this layer) *secretes organic, unazotized molecules which form the new thickening layer.*

I have further shown, in the first part of this essay, that in consequence of disturbing external influences, in the cells of various Algæ, *the mucilaginous layer is retracted, in places or entirely, from the wall, and produces a membrane on the surface, which becomes free, and bounded externally by water.* This membrane is not merely similar to cell-membrane in outward conditions. It presents itself as such in all its characters, so that, in particular, it has the power of growing out, either to produce a radical hair (*Bangia*), or a new ramifying and fructiferous filament (*Achlya*).

Even mucilage, mixed with various other contents, which had escaped from injured Algæ-cells into water, and lay scattered in detached portions in this, sometimes presented to me a bounding layer on the surface, which I could not distinguish from the delicate membrane, such as occurs on young cells. This bounding layer is wanting to mucilage which has just escaped from the injured cell. It is evident that it was produced by the mucilage.

These three facts prove, *that organic, unazotized molecules are secreted on the surface of living vegetable mucilage, and these inclose the mucilage in the form of a membranous layer.** Whether mucilage be free or lie in contact with

* I here presume to add a remark on the term "mucilage" (*schleim*, mucus). Most vegetable physiologists use the word, partly for vegetable gelatine, partly for gum; on the other hand, Schleiden applies it to the

a membrane makes no difference as to its function. Even in regard to the secreted layer, the distinction is not essential, and exists only in so far that in the one case this is called a *membrane*, in the other a *layer of thickening*. That there is no distinction between membrane and thickening layer is proved by the formation of membrane on the surface of a partially free mucilaginous layer, in the cells of Algæ. There the newly-formed piece of membrane passes continuously into the innermost layer of thickening; or, in other words, the gelatinous deposit secreted simultaneously over the whole surface of the mucilaginous layer, appears in some places as a layer of thickening, in others as a membrane.

If we conclude from the fact that the mucilage produces membrane or layers of thickening through secretion on its external surface, and that there is no essential distinction between them—from the formation of membrane to that of cells, it follows logically *that the membrane must originate through secretion from the mucilage in all cell-formation*. This conclusion is very strongly supported by certain phenomena in cell-formation itself.

proteine-compounds. An agreement between these views would not be readily effected. In addition there is a substance which is called *schleim* by both parties; this is the homogeneous, thickish, colourless matter, forming the total contents of the young cell, and the homogeneous, denseish, colourless ingredient in the contents of old cells. If, now, *schleim* is to have the signification of one or other (ternary or quaternary) of the *chemical* substances, it is incorrect to call the last-mentioned *schleim*. For this is certainly not a pure substance, but at the least a mixture of ternary (gum and sugar) and quaternary substances (proteine-compounds). This mixed matter is of the greatest importance in the life of the cell, since it is effective in cell-formation, in the first instance fills the whole cavity of the cell, subsequently lies upon the wall as mucilaginous layer, and traverses the cavity in currents of circulation, lastly, forms the contents of many utricles. (See the Essay 'On the Utricular Structures' in this volume.) It therefore requires a special name, and since the term *schleim*, on the one side, may certainly be spared from the nomenclature of ternary and quaternary organic matters, while on the other it is already in use in the proposed sense, it would be most advantageous to name the homogeneous denseish substance of the vegetable cell-contents, composed of mingled ternary and quaternary matters—schleim. [Mohl has proposed, and Schleiden and others have adopted, a better name, *protoplasma*, which has solely a *physiological* value, confusion resulting from the misuse of a term having a chemical signification.—A. H.]

I have already remarked* that, in the *abnormal cell-formation* in the cells of Algæ, a great multiplicity of conditions occur in regard to the contents which produce the membrane, and that a continuous series of gradations exists from abnormal cell-formation to the normal phenomena of cell-life. Sometimes a free cell is formed by a small portion of homogeneous mucilage, sometimes by a larger quantity of mucilage containing chlorophyll and starch; sometimes a considerable portion of the cell-contents produce, here a membrane, there layers of thickening; sometimes the whole contents form either a perfect membrane, or partly membrane, partly thickening layer, or a complete layer of thickening. These various phenomena are all connected by a number of intermediate states, so that the necessary cause and nature must be alike in all.

Since now, in some cases (if, namely, the mucilage borders on an existing membrane or on water) it is certain that the membrane cannot originate in any other way but through secretion from the mucilage, which is afterwards inclosed, we must undoubtedly assume a like origin in the other cases, where a part or the whole of the surface of the mucilage is bounded by fluid, unazotized or azotized contents. Consequently, in free abnormal cell-formation, the membrane is formed through secretion from the portion of contents which becomes a cell, and by no means in any other way from the rest of the contents of the parent-cell.

Passing from the abnormal parietal and free cell-formation to the *normal parietal cell-formation*, we find here also that the phenomena themselves lead to that assumption through a conclusion deduced from analogy. I have already discussed this at length in the section on parietal cell-formation. The contents of the parent-cell divide into one or more portions. The new membrane originates in some places between the mucilaginous con-

* Pages 97, 99, 114.

tents and the wall of the parent-cell, in some places between the mucilaginous contents and the wall of the simultaneously-produced fellow secondary cell. Here again no other hypothesis is possible but that of the origin of the membrane through secretion from the mucilaginous contents. The surface of the contents secretes layers of thickening up to the moment when cell-formation begins. The layer secreted *at* this moment is the rudiment of the membrane of the new cell.

In *free* normal cell-formation, lastly, the phenomena, if they do not exclude every other theory, are not unfavorable to the hypothesis founded on analogy. The most indubitable case is that in *Achlya*, where the sporangium-cell sometimes originates by parietal, sometimes by free cell-formation. Since here, in the one case (in the parietal mode of origin) the membrane is produced through secretion from the contents, it is certain that the same happens in the other case. In the formation of the germ-cells of Algæ, Lichens, and Fungi, and in that of the endosperm-cells in the embryo-sac, the phenomena admit of a twofold explanation: either that the membrane is a *secretion* from the portion of contents becoming isolated, or that it is a *deposit* from the fluid of the cell surrounding the isolated portion. Schleiden and Schwann have, as is well known, maintained the latter explanation. They found an analogy for it in the inorganic crystallization, but I believe that there is no analogy to it in the region of organic processes. On the other hand, the former explanation finds its certain analogy in lignification, in abnormal free and parietal, and in normal parietal cell-formation. Thus there exists no reason why we should not assume the origin of the membrane in consequence of secretion from the contents, to be certainly established also in free normal cell-formation.

The examples of the formation of membrane, in the manner we have just seen, fall into two categories: 1, Those in which the phenomena directly require the hypothesis that the membrane is formed through secre-

tion from the contents; 2, Those in which the phenomena do not oppose this hypothesis, and at the same time do not afford the slightest probability to any other assumption. Thus no objection can be made against the conclusion from analogy, so much the less that the examples of the second category do not include any single point not found in the first category which might suggest a process of a different nature.

From the foregoing discussions I must express the definition of the *formation of membrane* in the following terms: *The cell-membrane is an investment lying upon the surface of the contents, secreted by the contents themselves.* The membrane of a cell is the product of its own contents, as well in the beginning as subsequently. It does not originate through the chemical action of one substance upon another of different kind; its formation is an organic process, and in fact a process of secretion. This theory of the formation of membrane is, as we have seen, an immediate consequence of the facts, and avoids those formal and material errors which are connected with the theories of Schwann and Schleiden, and of which I have spoken elsewhere in the definition of a cell.

The other essential epoch in cell-formation is the *individualization of a portion of the contents, which becomes transformed into a new cell.* Here again we must, at the outset, distinguish between *normal* and *abnormal cell-formation.* In *abnormal cell-formation,* the mode in which the contents become individualized does not depend on a definite law, but on mere external, accidental circumstances. Large or small, many or few, portions of contents become isolated and form new cells. The idea of individualization of portions of the contents is here altogether vague, since it gradually loses itself in the opposite process.

I have already repeatedly noticed a series of phenomena which the *abnormal cell-formation* presents in living cells. The one extreme is exhibited where a minute free portion of contents, composed of mucilage alone, becomes clothed

by a membrane; the other is where the contents of a cell become detached from the walls only in places, and produce new membrane on these places. One extreme is a perfect cell-formation; the other merely a slight alteration of the form of the cell, combined with a partial production of new membrane. One extreme is the production of a new individual cell; the other is the reorganization of the partially injured individuality.

Between the two extremes occur a quantity of intermediate stages, in which it is doubtful, in particular cases, whether the old cell persists in an altered form, or whether a new cell has replaced it. The fact is certain, but the explanation is furnished by the observer. In all those cases where the mucilaginous layer is merely detached in places from the cell-wall, and produces pieces of membrane, we always recognize the cell as the same, with partially altered form and membrane. In all those where portions of the contents become isolated, and complete their separation from one another by the formation of membrane, we suppose new cells to take the place of the parent-cell; but if the entire contents of a cell are detached from the wall, become isolated, and then form a new complete membrane, we may call this a *cell-formation*, as well as we can call it *formation of membrane*. The contents of the old and new cell are exactly the same, the walls altogether different. Is a new individual formed, or is the individual merely reorganized (through regeneration of an organ)? This case stands just midway, and admits either explanation equally well. A step toward one side (if not the whole contents, but merely a portion, become detached from the wall), or one step toward the other (if not the whole contents, but merely a portion of them become completely isolated), will strictly decide the explanation to be either reorganization of the cell, or cell-formation.

The transition occurs again in a different way. If the contents of a cell become detached from the wall in one place, and acquire a new coat of membrane over this

place, while a larger or smaller portion of the contents are lost and become dissolved, through the separation, we shall always regard a cell altered in this manner as the same. It has indeed lost a part of its contents, and acquired a partially different membrane; but the greater portion of its contents and membrane remain unaltered. On the other hand, if a very large quantity of the contents separate and disappear by solution, we may regard the remaining portion, which becomes inclosed by a membrane, as we please, either as the altered original cell, or as a new one. If the detached portion of contents, instead of undergoing solution, remain living and acquire a membranous coat, two new separate cells will have replaced the original cell. We must, therefore, assume that cell-formation takes place here. Of the three cases mentioned, the first is undoubtedly a reorganization of the individual cell; the third, undoubtedly a production of new cells; the second is either one or the other, according as it is compared with the one or other process.

The result of these considerations is: *that abnormal cell-formation cannot establish any firm and absolute definition for the process of individualization of the portions of contents for the purpose of cell-formation;* because this process is essentially uncertain, and merely different in degree from that which stands in opposition to it.*

Passing now to *normal cell-formation,* we find the process of individualization of the portions of contents connected with determinate laws. We find no phenomena here, forming transitional stages towards a different process, in any way, towards that of mere reorganization of the cell. The individualization of the contents for the purpose of cell-formation appears, in general, under four different forms:—

1. *Solitary, minute portions of the contents become iso-*

* I was compelled to establish this fact somewhat at length, because many abnormal phenomena of cell-life have already been taken as evidence in discussions on cell-formation. They are testimony for the *formation of membrane,* but not for that *of the cell* generally.

lated in the interior of the rest of the contents of the parent-cell (Formation of free germ-cells in Algæ, Lichens, Fungi, and of the endosperm-cells of Phanerogamia.)

2. *The entire contents of one cell, or of two cells connected by conjugation, unite into one free, globular, or ellipsoidal mass* (Formation of the germ-cells of Zygnemaceæ).

3. *The entire contents of a cell divide into two or more portions* (parietal cell-formation in cell-division.)

4. *The entire contents of a short branch of a cell, or of the terminal portion of a longer branch, separate from the rest of the contents of the cell* (parietal cell-formation in the so-called constriction, as, for instance, in the formation of the germ-cells of several Algæ [*Vaucheria*, &c.] and many Fungi).

The phenomena exhibited by the individualization of the contents, in normal cell-formation, are externally the same as in abnormal cell-formation. In abnormal cell-formation, external, accidental influences exert a disturbing action on the life of the cell. In normal cell-formation, the *presence of a nucleus* must be especially counted among the conditioning causes. I have demonstrated it to be in the highest degree probable that nuclei are always present both in parietal and free normal cell-formation. They are wanting in abnormal cell-formation, and in this lies the essential distinction between normal and abnormal cell-formation.

If we may presuppose the necessity of the presence of a nucleus in the normal individualization of portions of contents, the processes must be completed in the following ways, in the four forms of individualization just mentioned:—

1. One or more nuclei originate in the contents of the cell. Each of these collects the contents in its immediate vicinity upon its surface. These portions of contents are composed of homogeneous mucilage, or mucilage with which is intermingled other assimilated substances, such as chlorophyll or other colouring matters, starch, oil, &c.

Through this, free cells originate in the contents of the parent-cell. The nuclei are in some cases already visible during the individualization of the contents; sometimes they do not become visible until afterwards; in certain cases they have not hitherto been perceived.

2. A single nucleus originates, which lies in the midst of the accumulation formed by the whole contents of one cell, or of two conjugated cells. This accumulation forms a single free cell in the empty cavity of the parent-cell. The nucleus does not become visible until the development of the germ-cells to new plants.

3. Several nuclei originate in the contents of the parent-cell, distributed in a regular arrangement. Each of these individualizes the contents of the parent-cell, through attraction, with a force only limited by that of the other nuclei. At the limits which separate the field of action of each nucleus, which, *ceteris paribus*, are equally distant from each pair of nuclei, the membranes are formed. In other words, the whole contents of the parent-cell divide into just as many portions as there are nuclei; a nucleus lies pretty nearly in the middle of each portion; the portions are separated from each other by an extremely narrow space, in which each portion of contents secretes its own membrane. The parent-cell divides, by parietal cell-formation, into several secondary cells.

4. A single nucleus originates in a short branch (in the prolonged part), or in the terminal portion of a longer branch of a cell. Under its influence, the whole contents of the short branch or of the terminal portion of the longer one, separate from the rest of the contents of the cell and form a new cell, the membrane of which is partly parietal (in contact with the internal surface of the branch), and partly free (directed towards the cavity of the older cell). But the parent-cell, excepting in the loss it has suffered, remains unaltered. The nucleus has never been perceived yet during the actual process; it not unfrequently becomes visible afterwards.

The definition of the INDIVIDUALIZATION OF THE CELL-

CONTENTS *for the purpose of normal cell-formation is consequently this; that a nucleus is formed, and that this nucleus individualizes a portion of the contents by attraction.* The portions may be indeterminate or determinate. If the former, the quantity of contents isolated around the nucleus is uncertain. If the latter, either the whole contents or a definite fraction ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{7}$, $\frac{1}{8}$) becomes individualized around the nucleus, the denominator of the fraction giving the number of simultaneously individualized portions of contents.

CELL-FORMATION is the *individualization of a portion of contents, immediately followed by the formation of membrane.* The definition of cell-formation depends on the combination of the two constituent definitions. *Normal cell-formation,* therefore, in so far as it is endogenous, consists in this:—

A nucleus is formed in the contents of the parent-cell; this individualizes a portion of the contents by attraction, and this individualized portion becomes coated with a membrane by secretion over the whole of its surface.

But since, in animals, cell-formation also occurs outside cells, likewise commencing with a nucleus, and since in the *generatio spontanea* the first cells of plants or animals are formed either in external media or in other cells, in such a manner that these certainly cannot be regarded as parent-cells in the proper sense of this word, the definition of normal cell-formation must be brought into a more general expression.

In organic substances (which in animal cell-formation must contain proteine-compounds, in vegetable, azotized and unazotized compounds, such as albumen, gum and sugar) *a nucleus originates which, by attraction, individualizes a portion of the organic substances surrounding it; the individualized portion of organic substances becomes clothed by a membrane through secretion over its whole surface.*

In vegetable cell-formation the substance secreted as membrane is composed of ternary unazotized substances.

The homogeneous substance lying on the surface of the cell-contents and secreting the membrane, is mucilage (*schleim*) (albumen mixed with gum and sugar). Either the whole portion of contents individualized through the influence of the nucleus consists of mucilage, or of mucilage with which other matters are mingled; in the latter case, however, the extreme outer surface is always formed by mucilage. There are two especial properties of the mucilage which are of essential assistance in the formation of cells. The first is this, that whenever it becomes free or isolated, it acquires a perfectly smooth surface, on which the strongest magnifying power fails to discover the slightest prominences or depressions. A second property is, that where mucilage and other solid matters unite into a definite form, a portion of the mucilage always forms a superficial layer, the other substances being as it were repressed by it. The latter may be seen, both when the contents of a cell (especially of the cells of Algæ) flow out in water, and when through injury to the cell the contents become retracted from the walls, and divided into isolated portions. Through the homogeneous mucilage forming a continuous enveloping layer, or any portion of contents becoming individualized, this becomes at once a connected whole with definite boundaries. Through the mucilage possessing a perfectly smooth external surface, is produced a membrane, continuous and smooth, even at the very first moment of its formation.

Having become acquainted with the definition of cell-formation, and in it the conditions necessary to the process, we will now examine more closely some of its external relations. The cell may originate *in another cell* or *outside cells.* In the vegetable kingdom the law holds *that all normal vegetative cell-formation takes place solely inside cells; moreover, that all normal reproductive cell-formation, for the purpose of propagation, likewise occurs exclusively in the interior of cells.* Only the first cells of individuals originating through *generatio æquivoca*, are formed outside cells.

Schleiden was the first to express the formation of cells in cells as the universal law for vegetables. In many researches on the most diverse orders of the vegetable kingdom, and on the most varied organs of plants, I have never met with the formation of cells outside cells. Minute investigation in the proper stages of development always shows that the new cells proceed from parent-cells.

Meyen,* indeed, makes a portion of the cellular tissue of the young anther become dissolved, and new cells to originate in the homogeneous mucilage. But I have shown that Meyen mistook a very thin, delicate tissue for amorphous mucilage.†

Mirbel‡ considers that the cambium in the root of the Date-palm consists of an amorphous, homogeneous, thick fluid,in which the cells are formed. But in the roots of the Date-palm, as in all other cambium in entire sections, I find a continuous cellular tissue, and never any interruption by an amorphous mass.

Schleiden§ came to a similar result with regard to the cell-formation in cambium.

Endlicher and Unger‖ recently affirm cells to originate also through intercellular formation, appearing first as cavities in the intercellular substance, and acquire proper walls subsequently through the condensation of the latter. But if cells lie in a gelatinous mass, this is by no means a proof that they have originated in this. The history of development must decide whether the cells have been produced from the gelatinous mass, or the gelatine from the cells. My researches on the Algæ and Fungi show to me that, without exception, the cells exist first, and the gelatinous matter which subsequently surrounds them is produced by the cells. In the simple plants, such as *Nostoc*, *Palmella*, &c., the development may be traced from the very first cell. In the more complicated plants,

* Physiologie, Band iii, 119; pl. xii, fig. 2.
† Zur Entwickelungsgesch. des Pollens, p. 10, figs. 2-7, 31-36, 47, 48.
‡ Nouvelles notes sur le Cambium; Archiv de Muséum, tome i, pl. xxi.
§ Grundzüge d. wiss Bot. 1st Ed. vol. i, p. 199.
‖ Grundz. der Botanik, p. 33.

as, for instance, the Fucoideæ and Lichens, a thin-walled, parenchymatous cellular tissue exists at first, and the cells subsequently separate while gelatine makes its appearance between them. In many of the more complex Algæ and Florideæ I have been able to trace the development of the organs, step by step, from the first cell, and to bring this within definite laws of cell-formation. It thus becomes possible to determine in the perfect tissue, in which parent-cell each cell has originated. But it renders the hypothesis of an intercellular formation of cells wholly impossible.

Quite recently, Mettenius* has stated that the cells in the ovule and in the anthers of the Rhizocarpeæ, originate in an amorphous fluid, which is inclosed in a sac formed of a simple layer of cells. My own researches, however, do not agree with this description. I have many times seen a delicate-walled parenchyma during the cell-formation in these organs, and therefore am compelled to believe that the origin of the parent-cells of the pollen in the Rhizocarpeæ takes place in a similar way to that in the Phanerogamia. In a single organ, namely, in the antheridia of Mosses and Ferns, I am still in doubt regarding the cell-formation, not on account of anything unfavorable to the theory, but because generally nothing at all is seen. It is, besides, to be remarked, that the spermatic vesicles which are formed there are without doubt, utricles analogous to cell-nuclei (not to cells), and further, that on the other antheridia (of the Characeæ and Florideæ) no extra-cellular cell-formation takes place.

The law being established, that in plants both the vegetative and reproductive normal cell-formation takes place only *inside parent-cells, the relation of the cell-formation to these parent-cells* next demands consideration. The first question is, in what *number* and what *position* do these secondary-cells originate in the parent-cell.

The *number of secondary cells* is determinate or inde-

* Beiträge z. Kenntniss der Rhizocarpeen, p. 10 (1846).

terminate. In general, the rule may be stated, *that in vegetative cell-formation only two cells are formed from one parent-cell, in reproductive cell-formation, on the other hand, the number varies from one to an indefinite quantity,* and that here the smaller numbers (1, 2, 4, 6, 8) are constant, while the larger numbers (5 to 100, or more,) vary.

In the first place, as to *vegetative cell-formation,* from comprehensive researches in the Algæ, Fungi, Lichens, Florideæ, Mosses, Charas, in the vascular Cryptogamia and the Phanerogamia, I believe I am justified in venturing to express, as an universal law, *that here always two secondary cells originate in one parent-cell,* or, in other words, *that one cell divides into two.* Views and representations opposed to this I am compelled to regard as certainly incorrect.*

In *reproductive cell-formation,* the cells originate in various numbers in the parent-cell. *One* cell is found constantly in the formation of the germ-cell of the Zygnemaceæ, and several other Algæ and Fungi, also in the formation of spores and pollen-cells in the special parent-cells. Two, four, six, or eight cells are formed constantly in one cell in the formation of the germ-cells of several Algæ, many Fungi, of Lichens, also in the formation of the special-parent-cells of the Florideæ, Hepaticæ, Mosses, Ferns, and Lycopodiaceæ. The number varies from two and four to eight in the formation of the special-parent-cells of Phanerogamia. The secondary-cells originate in indefinite quantity in the formation of the germ-cells of many Algæ and Fungi, and in the formation of the endosperm-cells in the embryo-sac.

The *position* of the secondary cells in the interior of

* Thus Schleiden and Vogel figure three young cells in an epidermis-cell which has grown out into a hair. (Beiträge z. Entw. der Bluthenth. bei d. Legumin., Act. Acad. C. L. C. N. C. xix, 1, pl. x, fig. 38.) Schleiden also represents three secondary cells in a parent-cell from the terminal shoot. (Beitr. z. Anat. d. Cacteen; Mém. de l'Ac. Imp. des Sc. de St. Petersbourg, Sér. vi, t. iv, pl. viii, fig. 9.) In both the places named I have satisfied myself that only two cells are formed in a cell; that when, however, one of the latter quickly divides again, the appearance may readily be mistaken for three cells originating in one parent-cell. See pp. 119, 120.

the parent-cells is partly regular, partly irregular. The arrangement of the secondary cells is regulated by definite laws in vegetative cell-formation, and these produce a definite internal structure and external form of the organ, as I have pointed out in another essay,* in *Delesseria Hypoglossum*, and in the Mosses. In reproductive cell-formation we usually find a regular position connected with a definite number, an irregular arrangement with an indefinite number; when the germ-cells (in Fungi and Lichens) originate in the constant number of 2, 4, 6, or 8 in one parent-cell, they mostly lie in a row in the axis of the parent-cell, or else they exhibit a mode of arrangement having a definite relation to this axis. When the special parent-cells are formed in the constant number of four together, they are arranged tetrahedrally about the centre of the parent-cell. But when the cells originate in indefinite numbers (as in the formation of the germ-cells of many Algæ and Fungi, and of the endosperm-cells), there is nothing determinate in their relative positions in the parent-cell.

After the number and arrangement of the secondary cells within the parent-cells, comes the further question, in what way *do the particular parts of the parent-cell co-operate in cell-formation?* The *membrane*, as we have seen, in free and parietal cell-formation, bears no immediate share in the production of the new cell. It is merely the *contents* of the parent-cell which here come into consideration. Normal cell-formation may, in reference to the material relation of the parent-cell and secondary cell, be brought into the following categories:

1. *A secondary-cell originates in a parent-cell, entirely filling up the cavity of the latter*, and perhaps including the whole of its contents. Under this head are found the origin of the spore-cells in the special parent-cells of the four-spored Cryptogamia, namely the Florideæ, Hepaticæ, Mosses, Ferns, and Lycopodiaceæ, and of the pollen-

* Zeitsch. für wiss. Botanik. Schleiden und Nägeli. Part ii (1845).

cells in the special parent-cells of the Rhizocarpeæ and Phanerogamia. The special parent-cells contain a central nucleus. This disappears, and soon afterwards we find in the special-parent-cell a spore- or pollen-cell completely filling it, with a (primary) lateral nucleus. How this cell is formed, whether free in the contents, or around the whole contents, is still unknown.

2. *The central primary nucleus of the parent-cell divides into two secondary nuclei; the entire contents separate into two portions, each of which has one of these nuclei in its interior. The parent-cell divides by parietal cell-formation into two cells with central nuclei.* This process is met with in the formation of cellular tissue in the Algæ (and the Lichens?), and in the reproductive cell-formation of many one-celled or several-celled genera of Algæ.

3. *A central nucleus appears in the parent-cell, and divides into two secondary nuclei. The contents separate into two portions, each of which includes one of these two nuclei. The parent-cell divides, by parietal cell-formation, into two cells with lateral nuclei.* Here are to be enumerated the formation of cellular tissue of (most Fungi?) Florideæ, Hepaticæ, Mosses, Ferns, Lycopodiaceæ, Characeæ, Equisetaceæ, Rhizocarpeæ, and Phanerogamia. It is still uncertain whether the central, dividing nucleus is the primary nucleus of the parent-cell, becoming detached from the wall, and advancing into the centre,—or whether it is a newly-formed nucleus, originating in the centre, after the solution of the primary, lateral nucleus. The settlement of this question will at once decide, whether this cell-formation is actually different from that mentioned under 2, or is to be considered as merely a peculiar modification of it. With regard to the formation of the stomates of the Phanerogamia, I have expressed the opinion, that the primary nucleus of the epidermal cell becomes absorbed and that a new central nucleus is formed.* Mohl,† on the other hand, asserts of the same

* Linnæa, 1842, p. 238. † Vermischte Schriften, p. 258.

case, that the primary nucleus does not become dissolved, but that it is this which becomes divided.

4. *Four nuclei are produced, probably by the division of the primary central nucleus into two, each of which becomes again divided. The four nuclei assume a tetrahedral arrangement. The contents separate into four portions, each of which contains one of those nuclei in its centre. The parent-cell divides by parietal cell-formation into four tetrahedrally-arranged secondary cells.* I have hitherto only observed this process in the new single-celled genus of Algæ *Tetrachococcus.**

5. *The lateral (primary) nucleus of the parent-cell becomes absorbed. A new secondary nucleus makes its appearance in the centre of the parent-cell. At its sides originate two smaller nuclei.*

A. *The secondary nucleus of the parent-cell becomes absorbed. The contents separate into two portions, each of which contains one of those smaller nuclei in the middle. The parent-cell divides by parietal cell-formation into two cells with central nuclei. Each of the two nuclei divides into two nuclei, and each of the two cells divides again into two secondary cells by parietal cell-formation.*

B. *The two small nuclei divide, so that now four still smaller nuclei lie around the large secondary nucleus in the parent-cell.*

a. The secondary nucleus of the parent-cell becomes absorbed. The four small nuclei assume a tetrahedral arrangement. The contents separate into four portions, each having one of these four nuclei in the centre. The parent-cell divides by parietal cell-formation, into four tetrahedrally-arranged cells with central nuclei.

b. Some, or all of the four small nuclei divide, so that then from five to eight still smaller nuclei lie around the large central secondary nucleus of the parent-cell. The latter becomes absorbed. The contents separate into just as many portions as there have been small nuclei produced,

* Nägeli, Neuern Algensysteme. Zürich, 1847.

each containing one of them inclosed in its centre. The portions of contents are symmetrically arranged around the centre. The parent-cell divides by parietal cell-formation into from five to eight cells with the central nuclei.

The process described occurs only in the formation of the special parent-cells in the sporangium of the four-spored Cryptogamia, and in anthers. The modification given under A, I have observed in Florideæ, Mosses, and Phanerogamia; the modification B*a*, in Florideæ, Mosses, Ferns, Lycopodiaceæ, Rhizocarpeæ, and Phanerogamia; the modification B*b*, in Phanerogamia.

6. *In one parent-cell, or in two connected by conjugation, the whole of the contents unite into a globular or ellipsoidal mass, which is transformed into a free cell by the formation of a membrane on its surface.* Here refers the reproductive cell-formation of the Zygnemaceæ. Most probably, a central nucleus lies inside the contents, this, however, is in any case different from the primary nucleus of the one, or those of the pair of cells.

7. *New nuclei originate in a parent-cell, its primary nucleus becoming dissolved; each of these collects generally a very small portion of contents around it, which become coated by a membrane. The cells originate by free cell-formation in the contents of the parent-cell.* Here belong the formation of the germ-cells in some Algæ, in many Fungi, in the Lichens, and the formation of the endosperm-cells in the Phanerogamia.

8. *A cell grows out into a branch, and divides by parietal cell-formation into two cells, in such a way that one corresponds to the original cavity of the cell, the other to the expanded part.* Here are to be enumerated the formation of branches in Algæ, Fungi, Florideæ, &c. It exists probably in all plants, but may be recognised best in the organs composed of rows of cells. The origin of the cell-nuclei, and their participation in the cell-formation, is not yet certainly made out. It seems to me that the two following modifications exist, in respect to this:

A. The expanding cell possesses a central (primary)

nucleus before its growth begins, and retains it subsequently. A free nucleus also exists afterwards in the prolonged portion, and this probably originates spontaneously and independently of the primary nucleus of the original cell. *Each of the two secondary-cells possesses a central nucleus.* This branching cell-formation holds good for those plants in which the formation of cellular tissue follows the rule described under 2.

B. The expanding cell originally possesses a lateral (primary) nucleus. A second nucleus is subsequently found in the prolonged portion, probably originating spontaneously and independently of the primary nucleus. *Each of the two secondary-cells possesses a lateral nucleus.* This branching cell-formation occurs in such plants as have their cellular tissue formed according to the rule given under 3.

9. *A cell grows out into a branch. The whole of the contents of the branch* (if it be short), *or the terminal portion of its contents* (when the branch is long), *becomes isolated, and, by the formation of a membrane over its whole surface, is converted into a cell, which corresponds exactly to the cavity of the very short branch, or to the whole of the end of a longer branch.* In this way the germ-cells of several Algæ (e. g. *Vaucheria*) and Fungi are formed. The behaviour of the nucleus is not yet sufficiently known. The parent-cell possesses a lateral or central nucleus; the secondary cell likewise. The nucleus of the secondary cell probably originates in the branch, spontaneously and independently of the (primary) nucleus of the parent-cell. This mode of cell-formation is closely allied to that mentioned under 8. But there the division always occurs by means of a septum, which, as soon as it is thick enough, appears to be formed of two layers of equal thickness. From this condition of the wall we may conclude that two cells are simultaneously formed, dividing in the contents and cavity of the parent-cell. Here, on the other hand, only one lamella can be perceived in the curved septum, which

always has its convex surface directed toward the original cavity of the cell, and this lamella belongs to the cell formed in the branch. The cavity of the parent-cell at first appears to be closed in merely by the secondary-cell, subsequently it becomes closed in by its own piece of membrane. In this kind of cell-formation, therefore, as I believe, not two, but only one cell originates in the first instance.

VI.—THE GROWTH OF CELLS.

The cell is very varied in form at the moment of its origin. Cells produced by *free cell-formation* are always *globular* or *ellipsoidal*. Cells originating in numbers in a parent-cell, by *parietal cell-formation*, have *that form which is produced by the division of the parent-cell by straight or curved surfaces*. The variations of form under which these newly-formed cells appear are innumerable. The cell not unfrequently originates in a mathematically regular form, such as a sphere, ellipsoid, hemisphere, a quarter, segment, or section of a sphere, a cone, truncated cone, cylinder, semi-cylinder, a quarter, section, or segment of a cylinder, tetrahedron, cube, table, prismatic column, &c. &c.; but in most cases the form of the nascent cell is either intermediate between these mathematical figures, or exhibits all possible irregular figures, with plane (more rarely curved) surfaces. The faces and angles of the nascent cell are either all curved or all straight, or mixed. The number of faces by which the young cell is bounded varies, according to my investigations, from 1 to about 32, the number of plane angles from 0 to about 90, the number of solid angles from 0 to about 60.

From these facts it is evident how little the existing theory of cells is applicable, setting out from the spherical form, and deducing all the others from this as subsequent. In general I hold it as a rule that the cell retains the shape in which it originates. The shape is certainly altered in many cases; but taking a number as the test,

this is by no means the rule. When the cell does become altered in shape, it much more frequently happens that it passes from the polyhedral into the spherical, then from the spherical into the polyhedral form. This last, indeed, I believe only occurs in the endosperm-cells.

The growth of the cells is of two kinds. *Either the whole contents of the cell are simultaneously transformed, and the entire membrane expands at once*—I will call this *universal growth* (*allseitiges Wachsthum*),—*or new contents are continuously formed at one point of the surface of the cell, and with this new membrane*—I call this *apical growth* (*Spitzenwachsthum*).

In the growth of the cell it is necessary to distinguish between the growth of the contents and that of the membrane. The former appears always as causal and primary, the latter as caused and secondary. I shall here speak only of the growth of the membrane. This is a growth in thickness, and a growth in surface. The latter comes particularly into consideration in treating of the growth of the cell. It is conceived as an expansion resulting from the intussusception of organic molecules, and called a nutrition of the membrane. Without entering into any criticism of this theory, I will merely investigate, with what phenomena the growth of the membrane in surface is connected, in universal and apical growth of the cell.

When, in universal growth, the cell does not change its form, the membrane must expand uniformly in all parts. On the other hand, when the shape is altered, some parts of the membrane must expand more than others. The membrane consists of surfaces. In each of these faces the growth of the membrane must be decomposed into two factors, the expansion in the *two dimensions of a plane*. In each dimension we have three possibilities: either the expansion is $+x$, 0, or $-x$; either there is an expansion or none; or a diminution of the face of the membrane in this dimension. The last case, though rare, does occur in a few instances. The growth of the surface of a membrane, therefore, when the three possibilities in

each dimension are combined, exhibits, in general, nine possible cases, leaving out of the question that a multitude of differences in quantity may occur. In a cell where the growth is not uniform, we must distinguish at least between two faces; but cells occur with ten, twenty, and thirty faces. From this it may be conceived what an infinity of theoretically possible diversities exist for the universal growth of a cell-membrane in its totality, since this proceeds from the combination of so many and, more than this, such variable factors. I think, therefore, that in particular cases the growth of the membrane may be decomposed into its factors, but that it is impossible to establish general rules.

Schleiden* considers that the variations of form of cells result from unequal nutrition of the membrane, this taking place only in those places where one cell is in contact with another, or with a fluid;—moreover is more vigorous in those situations where a more considerable interchange of matters with other cells is going on, thus at the ends of elongated cells more strongly than at their lateral faces.†

Schleiden here starts from the facts, that the cells of the epidermis and of the septa in the air-canals are flattened; that in stellate and spongiform cells only the rays are in contact with other cells; that where a current of sap passes through a tissue, elongated cells are formed. The example cited, of *Caulerpa*, does not belong here, but to a growth of quite different kind, to *apical growth.*

The facts brought forward show the incontestible rule, if not absolute and unexceptional law; but I draw quite a different conclusion from them, namely, *that the cell-membrane grows least exactly where the greatest interchange of substances with external bodies takes place, and that it expands most where it is least occupied in receiving and giving off substances.*

I will first mention some negative reasons against

* Grundzüge d. wiss. Bot., 2d ed. i, p. 211.
† L. c. 250.

Schleiden's theory. If this were correct, we ought constantly to find the epidermal cell next the air *flat;* but there exist such as are not merely not flat, but of which the radial diameter is considerably greater than the tangental. Moreover, there ought to be a thorough distinction of form between epidermal cells in contact with water and those exposed to air, which is not the case. Again, the epidermal cells next the air should have a flattened outer surface, while in many cases they are elevated like papillæ. The cells of cellular plates (simple layers of cells) which exist in air, for instance the leaves of most Mosses, should be plane and flattened on both sides, which they often are not; while, on the contrary, cellular plates lying in water, e. g. Algæ and Florideæ not unfrequently have tolerably plane and flattened cells.

The positive reasons are more important than these negative objections. Assuming that a cell with equal diameters and cubical form becomes tabular, as may be the case in many cells of the epidermis and of the septa in the air-canals, the cell expands in two directions, which I will call the *tangental,* while it expands little or not at all in the *radial* direction; but the two faces to which the radial diameter is perpendicular, and which I will call *end-faces,* then expand, although in contact with air, not merely as much, but more than the other or *lateral faces.* If we assume that all three of the diameters of the cell were originally $= 1$, and such an increase to occur that both the tangental diameters become $= 3$, the radial diameter remaining $= 1$, we have the six faces, each of which originally possesses a square content $= 1$, now increased in such a way that the square content of the four *lateral faces* $= 3$, while the square content of each *end-face* has become $= 9$. In this case, therefore, the superficial square expansion of *a lateral face standing in contact with other cells is three times,* while that of *an end-face in contact with air is nine times* the original content. The latter is thus three times greater than the former. It may indeed be objected here, that the

expansion of the membrane depends solely on the nutrition of the lateral faces, a part of the latter having become end-face; but for this hypothesis we require a displacement of particular parts of the membrane, which has never yet been demonstrated in the cells of plants. Besides, I will show by another analogous example that such displacement really does not exist.

According to Schleiden, the elongated cells owe their shape to a current of sap, their ends being thus more nourished. On the other side it is to be objected, that if a cylindrical or prismatic cell is more nourished at its end than at its lateral faces, the cell will become proportionately broader not proportionately longer, since the ends determine the breadth of the cylinder or prism. But, according to the possibility mentioned in the previous example, a portion of the ends might continually become lateral faces; so that the ends would always remain the same size, while the lateral faces would grow by the addition of new portions of membrane, especially at both extremities (that is, near the two end faces). That this is not the case, however, is proved by such cylindrical or prismatic cells as have fixed points, on their lateral faces, from the conditions of which we may judge of the expansion of the membrane. The points of attachment of the branch cells are fixed points of this kind, in plants and organs of very simple structure. In Confervaceæ and Callithamniaceæ the branches often originate at a very early period; they are attached to the upper ends of the cylindrical lateral faces. Now, I observed in several cases *that the superficial contents of the lateral faces expanded ten to twenty times more than the end faces, after the origin of the branch, and that during this the branch always either remained near the end, or was but slightly removed from it.* The lateral face is free, and in contact with water; the end is in contact with a cell. According to Schleiden's theory, the end face ought to be more nourished than the lateral, since it effects the exchange of organic substances, while the latter only serves for the absorption of inorganic

nutriment. But just the reverse occurs here, and it is actually the lateral face which expands. The assumption that the lateral face is at all enlarged by portions of the end face being pushed over to the side is impossible here, since this must necessarily remove the branch-cell gradually away from the end. That the branch-cell is not all moveable on the lateral face, and that its situation may be regarded as a safe criterion here, is proved by the pore which the branch-cells of the Callithamniaceæ possess in the centre of their basal surface, and which certainly is not moveable. The same may be observed in Ceramiaceæ and in other Florideæ; as, for instance, in *Polysiphonia*, where the prismatic central cell frequently bears a branch.

The objection that the plants mentioned live in water, does not appear to me an important objection. For it can certainly at most be asserted, that membranes in contact with water will be more readily nourished than those exposed to the air; but not that membranes which are moistened with water, possess a more active nutrition than such as are applied against other cells. Besides which, that objection will, in any case, not apply to *Polysiphonia*, where the elongated central cells, the growth of which furnishes the same result, are wholly surrounded by cells. In order further to settle that doubt, I may add that cylindrical cells, the lateral faces of which are exposed to the air and the ends applied to cells, also, as for instance in several filamentous Fungi and many hairs of Phanerogamia, exhibit a similar condition to that of the cells forming the joints of the Callithamniaceæ; *that, namely, their lateral faces expand considerably more than their end faces*, which here alone officiate in the reception and transmission of fluid nutriment. The growth of the cell may be judged of here again by the relative position of the branch-cell, and in addition by the relative position of the nucleus of the cell. Hairs consisting of a single cell, are originally little hemispherical or conical cells; the parietal nucleus lies at some point of

their periphery. The cell often becomes twenty to forty times longer than it was at first. The cell is exposed by all its surface, except the base, to the air; it acquires its fluid nutriment solely through the basilar surface. If the membrane were principally nourished by the passage of nutrient matter through it, the basilar surface alone would be much expanded. Now, since the nucleus exists in the earliest condition, and since normally it is not moveable on account of its lateral attachment, it must, if the theory were correct, lie normally near the apex of the enlarged cylindrical cell, from the growth of the membrane at the base. But it lies, without distinction, sometimes at the apex, sometimes in the middle, and sometimes at the base of the cell.

Observations on elongated cells, or vessels with spiral, annular, or porous lignification, afford me similar results. If such cells or vessels grow after the lignification has become evident, the spiral fibres, the rings, or pores, separate uniformly on the whole of the lateral surfaces; the best proof *that such elongated cells or vessels expand at their lateral faces, and not at their terminal faces, where the current of sap passes through the membrane.*

The question still remains of the behaviour of the stellate or spongiform cells. They are at first parenchymatous, but by the secretion of air become separated from each other in the greatest part of the surface, remaining united together only in places. At the points of contact the cells elongate radially. Schleiden calls this a "growing-out" (*Auswachsen*). I see nothing in it but a mechanical drawing-out of those places which cannot separate from the other cells, through the air which has been excreted. The growth of the cells is a different and much more independent process, while the radiating elongation of the stellate and spongiform cells stands in direct relation to the quantity of air secreted. The undulated and dentate epidermal cells, however, which are *dove-tailed* into one another, and which Schleiden also cites, prove in any case nothing for his

theory, because a membranous surface, which is uniformly bounded at all points by another surface of membrane, must exhibit like behaviour at all points in reference to nutrition and expansion.

From the facts here brought forward, I deduce the conclusion, *that the cell-membrane normally expands less in those places where it serves for the reception and emission of the nutrient matters, or where it officiates in an interchange of substances or a current of sap; that, on the other hand, it normally expands more at those places where it has little or no nutrient matter to manage.*

The *apical growth* is altogether different from the universal growth of cell-membrane. In an earlier memoir on *Caulerpa*,* I have pointed out this apical growth, and discussed its characters at length.† The apical growths may be observed most easily in the filiform, branched, single-celled Algæ and Fungi, as in *Caulerpa*, *Bryopsis*, *Achlya*, &c. The lower part of the cell is quite perfect; little or no change occurs in the contents; the cavity is filled with clear, colourless fluid, and on the wall lies the mucilaginous layer, with the chlorophyll- and starch-globules: the membrane expands little or no more. Toward the extremity the membrane becomes thinner; it is there that new contents and new membrane are formed.

Immediately below the growing point lies a layer or small disc of homogeneous mucilage. Below, this passes into granular mucilage. To this follows a mass of granular mucilage, in which originate starch, chlorophyll, or other colouring matters. Still lower down, the solid contents are deposited upon the walls.

* Schleiden und Nägeli, Zeitschr. f. wiss. Bot., Heft i, p. 134.

† Schleiden (Grundz. d. w. Bot. 2d ed. i, p. 212) confounds the apical growth with the unilateral expansion of universal growth. It is by no means clear to me how he imagines *Caulerpa* to be "a body which at least *appears* like a single cell;" further, how "the most decisive proof" of anything can be deduced from this *appearance*. That *Caulerpa* actually *is* a single cell, follows, in my opinion, both from the researches I have published and from its relationship to *Bryopsis*, *Valonia*, *Codium*, *Halymeda*, *Udotea*, *Vaucheria*, &c.

In the disc of homogeneous mucilage lying in the *punctum vegetationis*, new homogeneous mucilage is unceasingly produced, so that it remains the same, although its lower edge is continually being converted into granules, and thus a portion unceasingly given over into the zone of granular mucilage. The lower part of the latter passes continually over to the coloured zone, since in it the formation of colouring matters, starch-granules, &c., begins. The lower part of this continually applies itself to the wall. In this manner the relations of the particular zones remain the same, although an unceasing process of transformation is going on in them.

The apical growth is thus connected with a production of contents, which takes place at the apex of the cellular branch.

The membrane, which is of tolerably uniform thickness in the lower part, becomes gradually thinner toward the end of the cellular branch. Immediately over the disc of homogeneous mucilage at the *punctum vegetationis*, the membrane is very delicate, as in a young newly-formed cell. It always remains so during the growth of the branch. The gelatinous matter secreted by the disc of mucilage is never appropriated to the thickening of the membrane, but solely produces the expansion of it necessitated by the growth of the apex. The membrane expands likewise beneath the apex, and exhibits phenomena there, similar to the *universal* growth of the cell without *apical* growth; at the same time it becomes thickened by deposition of new layers.

The membrane therefore exhibits different behaviour at the apex and beneath this part. At the apex it is continuously nourished, so to speak, or, as seems to me a more correct expression of the fact, new membrane is incessantly produced; the process of formation of membrane going on there remains the same so long as the apical growth lasts—in unlimited axes, therefore, it is unlimited also. Beneath the apex, the membrane grows

by universal expansion and thickening up to a certain point; the process of formation of membrane then gradually changes, and at length ceases.

The behaviour of the membrane at the apices of growing axes, and below these apices, exhibits exactly the same opposed relation, as the formation of membrane in cell-formation, and the universal growth of membrane after cell-formation.

The apical growth, therefore, consists not merely of a continuous production of contents, but also of a continuous production of new membrane at the apex of the axis.

Many cells with apical growth branch. They develope new branch-cells from their lateral surface, and these elongate by a repetition of the apical growth. Cells, also, which do not grow at the apex themselves, may send out a branch which exhibits apical growth; thus the cells which *grow out* into an appendage, as in the cells constituting the articulations of the Confervas, to form a branch-cell or a root; many cells of young bark or epidermis, to produce a hair or radical fibril; the sporangial cells of *Achlya*, to discharge the motile cellules (pl. III, figs. 4, 6, 8), &c.

The phenomena occurring in these cases, when they can be perfectly seen, as is possible, for instance, in *Bryopsis*, are as follows:—At some point on the surface of the cell, where the branch is to be formed, a little disc of homogeneous mucilage is produced immediately beneath the membrane; the mucilaginous layer here produces a definite quantity of new mucilage. Then the cell-wall becomes elevated into a little triangular, hemispherical, or conical papilla, filled with homogeneous mucilage. The papilla grows larger. The mucilage becomes granular at the lower part. The granulation of the mucilage advances continually upwards. The formation of chlorophyll, or other colouring matter, and of starch, commences at the base, and also progresses upwards. Then the mucilage at the lower end begins to apply itself upon the walls,

and the cavity is filled with colourless fluid, and comes into communication with the transparent cavity of the original cell.

The apical growth consequently commences with the new formation of homogeneous mucilage, which produces new membrane, and is continued by the persistence in new formation of membrane-forming mucilage.

The question now comes, what is the relation of the apical growth to universal growth and to cell-formation? The relation may be conceived in two ways: 1st, in reference to the contents; 2dly, in reference to the membrane. I will here, as in the universal growth, only enter upon the latter point.

Schleiden and Schwann have strictly discriminated two epochs in the development of the cell, namely, the origin of the membrane, and its growth. This distinction, however, according to the view of cell-formation above established, is certainly not so great as it appears in Schleiden's and in Schwann's theory. According to this theory, the material for the original production of the membrane is merely furnished by the mother-liquor, from which it crystallizes; the material for the growth of the membrane is, on the contrary, partly or wholly furnished by the cell-contents; it is, namely, deposited from the contents, or acquired by the endosmose and exosmose through the membrane.

According to my theory of cell-formation, the original production and the growth of the membrane have the same material cause. For both purposes, organic matter (in plants mostly gelatine) is secreted from the contents. Origin and growth are, in the same way, a product of the contents. They merely differ from each other relatively. The original production of membrane gradually changes into growth of membrane. A line of demarcation between them is quite arbitrary.

We see, therefore, that in this point the membrane behaves just like every other organism. In none, certainly, does there exist a strict and absolute boundary

between origin and growth. But if these two ideas are not absolutely different from each other, we shall still let them stand side by side as separate, in their relative difference.

When a cell is produced, a portion of organic matter becomes individualized and inclosed by a membrane, through secretion of organic substance. *With* CELL-FORMATION, *therefore, is connected an individualization of organic matter and a formation of new membrane.* When apical growth begins at a point of the surface of a cell, and a branch-cell is formed, a portion of homogeneous mucilage appears, which secretes membrane from within outward. *With the commencement of* APICAL GROWTH, *therefore, is connected the individualization of a portion of the contents and a formation of new membrane,* and, with the *continuous* APICAL GROWTH, *a continuous formation of new membrane.* I will consider these two points a little more minutely.

When secondary cells originate in a parent-cell, definite portions of the contents are repeated in such a manner, that from that time they possess an individual existence, having been up to that period undistinguished parts of the parent individual. When a branch is produced upon a cell, a definite portion of the contents is likewise separated, and indeed a small portion of the mucilaginous layer. This has from that time an individual vitality wholly distinct from all the rest of the contents. This little portion of mucilage is the rudiment from which a new branch is produced. The branch of the *ramified cell,* however, has quite the same import as the branch of a *many-celled plant.* In the ramified cell, as in the many-celled plant, it may, under certain circumstances, be detached and become an independent, new, and individual plant.

With the commencement of the APICAL GROWTH *in the formation of a branch, consequently, is connected the individualization or separation of a portion of the contents, as well as with cell-formation.*

These secondary cells originate in a parent-cell; the

cell-membranes are produced around the individualized portion by a new process of formation; the contents secreting organic matter around. When a cell-branch is produced, the individualized portion of contents forms membrane only on its outer face. The growing out of the cell-wall into a branch, however, does not, as I believe, happen through unilateral nutrition, but by a new formation, especially from the fact that the wall of the parent-cell or parent-branch is sometimes already tolerably thick and lamellated before the branch is formed, and because the growing out then assumes an aspect much more as if the membrane of the parent-cell were pushed outward and broken through, than as if it were expanded and formed a branch through nutrition. The origin of a cell-branch is distinguished from the origin of a cell by the fact, that in the former membrane is formed only on one side, in the latter over the whole surface; and that in the former the production of membrane is continued, in the latter exists but at one short period. *The* APICAL GROWTH, *therefore, like* CELL-FORMATION, *is connected with a formation of new membrane, but this is unilateral and continuous.*

In cell-formation, as soon as the membrane is formed, it expands by universal growth. In apical growth, as the new membrane is every moment produced, it also at once begins to expand by universal growth. In both cases a thickening of the membrane is combined, at the same time, with the expansion. In both cases, moreover, the expansion only persists for a time, and then ceases. Finally, in both cases, the expansion of the membrane is at all points equal or unequal; in uniform universal growth, the cell or cell-branch is not altered in form; in irregular universal growth, the cell or cell-branch assumes a shape different from that it originally possesses. As in cell-formation, so also in apical growth, the new formation of membrane and its growth, are only relatively different from each other. Both are conditioned by the secretion

of organic matters from the contents; one passes into the other without any definite boundary.

In reference to the *formation of membrane*, therefore, we may establish the following distinctions: *In* CELL-FORMATION, *an universal and momentary production of new membrane takes place. In* APICAL GROWTH, *an unilateral and continuous formation of new membrane appears. In* UNIVERSAL GROWTH, *which follows both cell-formation and apical growth, an expansion and thickening of the newly-formed membrane takes place.*

The apical growth may *begin* in a cell in two ways, in reference to its relations to the life of the cell in time and space. In the first case, the apical growth begins at once with the formation of the cell. *A portion of the contents becomes individualized, and secretes membrane over its whole surface*, whereby the cell is formed; *this new formation of membrane continues at one point of the surface, and the cell goes on growing in this direction.* The apical growth is here immediately connected with the cell-formation. It begins directly after the origin of the cell, before the universal growth has commenced.

In the second case, on the contrary, the cell first expands by universal growth. The membrane becomes thickened; the contents are applied upon the internal surface. *Then a portion of homogeneous mucilage is formed at one point of the surface, beneath the membrane, and with this begins a new apical growth*, as I have above described it. The apical growth, therefore, does not here follow immediately the cell-formation, but the universal growth of the cell. It may occur, either in a cell without apical growth, or in a cell with this, as on the lateral part of a cell-branch growing at the apex, and always appears as a *growing-out of a point of the surface.*

Through the first kind of apical growth the nascent cell grows longitudinally. By the second kind the cell branches.

The apical growth is also variable in its *duration. It*

is LIMITED *or* UNLIMITED, *according as it either ceases at a definite time, or continues as long as the plant lives.* Apical growth is limited in all cells, growing at the apex, of many-celled plants, also in many axes of unicellular plants. It is unlimited in particular axes of unicellular plants, as, for instance, in the main axis of *Caulerpa*, *Bryopsis*, &c.

Apical growth is not found in all cells; it is wanting even in the great majority of cells. I have observed it in unicellular Algæ, as *Caulerpa*, *Bryopsis*, *Vaucheria*, *Valonia*, *Codium*, *Halymeda*, *Udotea*; in unicellular Fungi, as *Achlya*, *Bremia*, *Mucor*, &c.; in the terminal cells of many Algæ, Florideæ, and Fungi, as, for instance, *Conferva*, *Dasycladus*, *Griffithsia*, *Polyactis*, &c.; in the roots of many Algæ, Florideæ, and Fungi; in unicellular hairs, or the terminal cells of many-celled hairs, in the pollen-tube; lastly, in all cells growing out into a branch, as, for instance, in the cells forming the articulations of many Algæ, Florideæ, Fungi, and the organs consisting of series of cells in the higher plants, moreover in the epidermal cells of the higher and lower plants, &c.

ON

THE UTRICULAR STRUCTURES

IN THE

CONTENTS OF CELLS.

BY CARL NÄGELI.

TRANSLATED FROM

SCHLEIDEN U. NÄGELI'S ZEITSCHRIFT F. WISS. BOTANIK, 184

BY ARTHUR HENFREY, F.L.S.

UTRICULAR STRUCTURES.

It is now some years since I first imagined that the phenomena exhibited by various bodies occurring in the cell-contents, and supposed to be solid, could only be explained by the hypothesis that they were utricles, having an inclosing membrane with inclosed contents. The minute size of the objects in question, the uncertainty which attributes to the appearances, on account of the different refractive power of different substances, and the circumstance that, already, repeated attempts to demonstrate cellular or utricular structures in the cell-contents had failed, impressed the necessity of great circumspection. I now lay before the physiological public my researches on the various forms of the contents in the various kinds of cells, only after extensive observations, and a confirmation of them by a comprehensive critical inquiry.

Earlier and more recent theories, which declare the cells to originate from starch- or chlorophyll-granules, and from which might be deduced a cellular structure of these granules, may conveniently be passed over as unfounded.

Earlier authors, likewise, who use granule and utricle as synonymous terms, and imply no distinction between the two expressions, merit no special mention.

More recently, granules and utricles have been placed in opposition to each other. The first are considered to be solid, the latter hollow. After this definition, the opinion that cells inclose only granules gradually gained the upper hand. Better instruments and more

accurate methods of investigation showed that what had been considered hollow, was really solid.

It was further attempted to show, in some granules, that their mode of origin was analogous to that of crystals and different from that of cells. They were supposed to be produced by a nucleus, through the deposition of layers on the outer surface.

Particular theorists persisted in the view that the formations in the contents were utricles, the analogy to a cell floating in their minds. The empirical proof that such an agreement existed was not given.

In the present condition of the researches, therefore, the questions are: *whether the so-called granules exhibit analogy with the crystal or the cell; whether they are solid or hollow; whether they are formed by the deposition of layers around a nucleus or in some other way?*

The first question is to be solved by the decision of the last two. The second is, of course, to be answered with the statement, that as a rule the so-called granules appear *solid.* But this does not establish anything in regard to their nature, since utricles may become or appear solid in various ways, while granules may at the same time be hollow. The answer to the third question alone possesses scientific interest, since it decides incontestably as to the crystal-like or cell-like nature.

Thus the entire question turns upon this: *Do the structures in the cell-contents originate by stratified deposition from without, and do they fulfil a vital process corresponding to this crystal-like mode of formation?* or, on the other side: *Do they originate in a similar manner to the cell; do they consist, like this, of a membrane and contents inclosed by this membrane; and do they exhibit, in general, in reference to the contents and membrane, analogous alterations during their life, to those we are acquainted with in the cells?*

Some time ago I pointed out two utricular structures in the contents of cells, the nuclear utricle,* and peculiar

* Schleiden und Nägeli, Zeits. f. wiss. Bot., i, p. 68; Ray Trans., 1845, p. 246.

utricles producing starch and chlorophyll, in *Caulerpa*.*
As a criterion of their utricular nature, I mentioned that they do not originate by deposition on the outside, that they inclose, in a complete membrane, contents distinct from this membrane, fluid, semifluid, or, sometimes, partially granular, that they grow by expansion of their membrane, and transform their contents, and that they propagate in the same way as cells.

In their essential peculiarities, therefore, these utricles present the character of cells; and we shall consequently, in the decision whether anything is an utricle or not, take especially into account the phenomena which are analogous to the phenomena of cell-life. On the other hand, we shall not determine whether anything is to be considered as an utricle by the circumstance of its being hollow or solid. Now, as cells occur which appear solid, either because their very delicate membrane is quite filled with contents, or because they are completely lignified, so also do such utricles present themselves. Moreover, hollow structures occur in the cell-contents which are not utricles.

I must enter more minutely into the latter point, because it has very often led to error. Homogeneous mucilaginous contents frequently exhibit transparent, colourless cavities. These are globular when they are isolated, or at least are not very near together; they become parenchymatous when they are closely crowded. They vary much in size; sometimes a great number find place in one cell, sometimes one, two, or three, occupy almost the entire cavity.

The mucilage in which these cavities appear is either of equal density throughout, or it is denser at the periphery of the cavities, and forms as it were a membrane around them. In such cases the cavities appear like utricles. This utricular structure is the more deceptive the more the density of the mucilage immediately on the surface of the cavity differs from that of the rest of the interior of the cell; it is still more deceptive when these

* Loc. cit. p. 149.

cavities are larger and exist in smaller numbers, and when the mucilage *generally* is more diluted and transparent. The cavities have, on the contrary, more the aspect of real, mere cavities, when they are small and numerous, and when the mucilage is dense and opaque.

These cavities contain water. They are seen in most cells which are passing from the condition in which the cavity is wholly filled with homogeneous mucilage, to that in which the mucilage is deposited upon the wall as a mucilaginous layer. They also occur, not unfrequently, at a subsequent period, when the cells contain a homogeneous mucilage besides the solid matters; I have seen them in this late stage of the life of the cell, from the cells of *Confervæ, Siphoneæ*, and Hyphomycetes, upwards to the parenchyma-cells of the Phanerogamia. They are here a normal phenomenon of cell-life.

The following is the probable mode of origin of these cavities. Larger or smaller quantities of water separate from the mucilage, and from physical laws acquire a globular form. From the loss of water, the mucilage contracts and becomes more dense. If the drops of water lie long unaltered in the mucilage, the layer of the latter in contact with the water coagulates through its influence, as is always more or less the case with mucilage or albumen in water. In this way originate in the cell-contents the colourless pseudo-utricles possessing a special membrane. In conformity with their origin we never see any other contents but colourless fluid in them, and never observe any alteration in their apparent membrane.

That this explanation of the normally occurring utricular cavities is correct, is proved by the abnormal formation of similar cavities, either when mucilage or albumen is mixed with water, or when we allow water to act endosmotically upon a cell containing homogeneous mucilage. In both cases, similar globular, colourless, sharply-defined cavities are frequently produced, the mucilage at the same time contracting and becoming more dense and opaque.

These cavities in the mucilage must by no means be

called utricles, because the utricles, according to their definition, are to be described neither as hollow spaces, nor as hollow spaces surrounded by a membrane. They must at least possess *a special membrane and contents subject to special metamorphoses.*

1. *Nuclear Utricles, Nuclei.*

That the nuclei are utricles I have pointed out in another place.* I then brought forward the following reasons in favour of this opinion:

1. When the nucleus admits of minute examination, in respect of size and density, a membrane, and contents distinct from this, may always be recognised. The membrane is only overlooked where the nuclei are too small, or where dense contents are inclosed in a delicate membrane. In the latter case, it is sometimes possible to render the membrane visible by the action of re-agents.

2. The membrane is different from the contents (by no means the outermost layer of them); it is not coloured by iodine and is composed of gelatine, while the contents are usually coloured brown by iodine and consist of mucilage.

3. The contents exhibit peculiar transformations, which are analogous to those of the cell-contents.

4. The membrane is proper to the nucleus (by no means a mere deposit from the cell-contents), as is proved by the *propagation* of the nuclei, which exhibits the same phenomena as the propagation of the cells.

I may add here that the membrane of the nucleus may sometimes be recognised very distinctly, when it becomes expanded through endosmose of water.†

Schleiden‡ thinks "that the nuclei become hollow

* Schleiden und Nägeli, Zeitsch. f. wiss. Bot., i, p. 68; Ray Trans. 1845, p. 246.

† See p. 110 of this volume, pl. ii, fig. 9, *i*, *k*, *l*, *m*.

‡ Grundzüge, second edition, i, p. 199. Schleiden reproaches me for an unsettled terminology. I have called the nucleus an *utricle* (*bläschen*), and

afterwards, since there is no trace of a membrane in the young free cytoblasts, and the origin of these even appears to contradict my view."—If the origin of the nuclei could be observed, this would afford the most decisive proof of one or other of the theories. Schleiden indeed describes the origin of the nucleus as a confluence or conglomeration of mucilage-granules and nucleolar-globules. I cannot agree at all in this opinion. The commencement of the formation of the nucleus may be quite definitely distinguished, while it is yet little larger than the globules of mucilage, and may be traced onwards uninterruptedly, any deposition of mucilaginous granules upon it being out of the question. On this point I refer to the preceding treatise, where it treats of free cell-formation in the embryo-sac.* The origin of the nuclei free in the cell-contents consequently affords no evidence in favour of the assumption, that they are solid granules without a membrane.

Schleiden says moreover, that "in young free cytoblasts no trace of a membrane is found." The youngest nuclei consist of a homogeneous substance. They are either more dense than the surrounding fluid, or, as is frequently the case in young parenchyma-cells, they are less dense than the surrounding mucilaginous contents, and appear like hollow spaces in it. In this youngest condition examination certainly reveals no membrane distinguishable from the contents; but this is not a circumstance which can be of weight in judgment of the nature of the nucleus. If optical instruments never become improved

used *nuclear utricle* (*kern-bläschen*), as synonymous with *nucleus*. I still know of no better terminology to substitute for it. On the one side, the analogy with the other kinds of utricle requires the name "nuclear utricle;" on the other hand, custom of language, brevity of expression, and the contrast with nucleolus, leads to the use of the term "nucleus." The confusion of language is always greatest when conceptions are in process of discrimination. Selecting from a hundred examples in botany, does not the same author use spiral vessel and spiral-fibrous cell, or liber-fibre and liber-cell as synonymous, although in regard to the last example, the word fibre already represents a perfectly definite conception.

* See page 103 of this volume.

so far as to enable us to distinguish the organic molecules, there will always be still entire stages, in the development of membranes, in which it will be impossible to distinguish them from the homogeneous contents lying close to them, and refracting light in a similar manner, and in which their presence or absence must be decided on upon other grounds.

The matter stands in a similar position in regard to cells. The relation of contents and membrane is evident in fully-formed cells, and it may be carried back by a conclusion from analogy to the young cells. The young cells in the embryo-sac, if they possess homogeneous and not granular contents, often do not allow of our perceiving the membrane for a long time. Free germ-cells (spores) of Algæ, Fungi, and Lichens, mostly attain a considerable size (at least as considerable as that of the nucleus mentioned by Schleiden), without the possibility of seeing the least sign of membrane, and yet they are young cells, to which no one will deny a membrane.* Moreover, cells occur also, about the size of young nuclei, on which no membrane is visible in their lifetime. Among these are some species of *Protococcus*, of *Palmella*, and of other Palmelleæ.

If, then, it is impossible to distinguish the membrane from the contents in *young* free cells, or in *small* free cells generally, on the other hand the membrane is usually visible in parietal cells at the moment when the cell originates, and in those very places where the apposition of the secondary cells forms a septum. The same occurs in nuclei which originate by the division of a parent-nucleus. Here, too, as in the division of cells, a septum is visible, formed by the two meeting membranes.†

The comparison of those free cells is especially necessary here, in which membrane and contents cannot be clearly distinguished even in the fully-developed con-

* See pages 95-6 of this volume.

† Nägeli on Cells, Part I, Ray Transl. 1845, pp. 231, 246.

dition. In them the septum is visible, as a line, only in the moment of the division. If, therefore, analogy with other cells does not afford evidence of the presence of a membrane to these cells, we can only draw conclusions in respect to it from the septum which is seen in the propagation; but when we can succeed in bringing two such free cells together, in such a manner that, where in contact, they are reciprocally somewhat flattened against each other, the two membranes become visible at once, as a septum, while at the remainder of the periphery, as before the union was the case at all points, nothing can be seen of the membrane. I have accomplished this in *Palmella*, *Protococcus*, and *Saccharomyces*.

Nucleus and cell then exhibit, in reference to their membrane and its relation to the contents, the same phenomena. In small and young free individuals, the membrane and contents are not distinguishable at first sight; they do not become so until they have undergone further development. In individuals, however, which originate through parietal formation, the membrane is evident as a septum in the earliest condition. The sole distinction, following from the nature of the case, which prevails between nucleus and cell is, that there are far more conditions of the nucleus than of the cell, in which a distinction between membrane and contents is impossible, since the phenomena are represented on a considerably smaller scale in the nucleus than in the cell.

After disposing of the objections above mooted, I proceed to a short exposition of the vital phenomena of the nuclear utricle.

The nucleus originates in two ways: either free in the contents of a cell, or by the division of a parent-nucleus. If the nucleus originates by division, the phenomena presented are similar to those in the division of a cell. A septum becomes visible in the parent nuclear utricle, dividing it into two halves (as in *Tradescantia*);* some-

* Nägeli on Cell-Formation. Ray Trans., 1845, p. 184, pl. vii, fig. 20.

times a nucleolus is visible in both halves (as in *Anthoceros*).* Since the division of the nucleus exhibits exactly similar phenomena to the division of cells, I conjecture that a *parietal formation of the nuclear utricle* must be assumed in the former case like the *parietal cell-formation*† in the latter.

The process just described may perhaps be borne out by the facts known regarding the division of the nucleus in animal-cells.‡ A large nucleolus appears in the parent-nucleus, and divides; the two secondary nucleoli retreat from each other, and the nuclear utricle divides into two secondary nuclear utricles, in such a manner that each of them incloses a nucleolus.

If we may draw conclusions as to the division of the nucleus from the division of cells, where the appearances are the same, the parietal formation of the nuclear utricle depends on the following events: *Two nucleoli appear in the parent nuclear utricle; the contents of this separate into two portions, each of which incloses a nucleolus, and becomes clothed by a membrane; the membrane of each of the new nuclear utricles is in contact partly with the wall of the parent-utricle, aud partly with that of its fellow, whereby a septum is produced in the parent-utricle.*

When the nuclei originate free in the cell-contents, the circumstances are probably the same as those occurring in the formation of free cells. It appears, namely, that, *first, a nucleolus is formed; that a layer of mucilage is deposited around this, and that the membrane of the nuclear utricle is produced upon the surface of the mucilage.* At least the phenomena which can be observed in the formation of free nuclei allow of this explanation, which is rendered probable by the analogy to free-cell formation. I refer the reader, on this point, to the article "*Free cell-formation*" in the preceding essay.§

* Loc. cit. pl. vi, fig. 38.
† Loc. cit. p. 284.
‡ Kölliker, Entwick. der Cephalopod., pl. vi, fig. 68.
§ Page 95 et seq.

When the nucleus originates free, it is in its earliest condition globular; when it originates with a fellow-nucleus in a parent-nucleus, it is originally hemispherical, but then, separating from its fellow, it rapidly assumes a globular shape.* The nucleus retains its spherical shape if central in its cell; it only becomes ellipsoidal when about to propagate; but if the nucleus occupies a lateral position in its cell, it becomes flattened on one side. Seen in front, it then appears circular or ellipsoidal, while laterally it seems more or less compressed.

The growth of the nucleus is sometimes very slight; sometimes an expansion of from twice to ten times its diameter takes place.

The membrane of the nucleus never acquires any considerable thickness, and never exhibits lamellation or lignification as in cells.

Young nuclei, as well when they have originated free as by division, generally possess homogeneous, colourless mucilaginous contents. These may be dense and opaque, or almost transparent. Subsequently they become granular, and we may then distinguish a transparent fluid, mucilage-granules, starch-granules, chlorophyll-granules, and drops of oil. Sometimes the homogeneous and granular mucilage becomes deposited in the form of a layer on the inner surface of the membrane, so that the rest of the cavity is filled merely with watery fluid. Sometimes the nucleus contains amorphous colouring matter, so that it appears homogeneously red† or green.‡ Amorphous chlorophyll may also clothe the inner surface of the membrane, merely in patches.§ For more minute particulars, I refer to my earlier essay on this subject.‖

There are generally from one to three nucleoli in the contents of the nucleus; sometimes their number rises to five and six. These nucleoli appear to be rarely absent. Probably they are always present, and merely invisible

* Nägeli on Cell-Formation; Ray Trans., 1845, p. 184, pl. vii, fig. 20.

† Loc. cit., 1845, pl. vi, fig. 26.

‡ Loc. cit. pl. vi, figs. 36-40.

§ Loc. cit. pl. vi, fig. 41.

‖ Loc. cit. p. 219 et seq.

on account of the minute size, or the opacity of the nucleus. It is, moreover, probable, when at a later period several nucleoli are met with in one nucleus, that one alone existed in the first instance, and that the rest have originated subsequently. I have already expressed my opinion on this point in the section on "*Free cell-formation*" of the preceding essay.*

The nuclei terminate their existence either by solution, in consequence of weakness resulting from age, or by propagation. The mode in which nuclei propagate, has already been described when treating of their origin.

2. *Spermatic Utricles.*

The spermatic utricles are those in which the spermatic filaments originate. Hitherto they have been called cells or cellules. I formerly thought that they might have the import of nuclear utricles, because always one such utricle appeared in a cell in the antheridia of the Characeæ, and because a nucleolus always existed previously in each utricle.

Without intending now to deny this analogy, I believe that the spermatic utricles are not perfectly identical with the nuclear utricles; in the first place, because the production of the spermatic filament is a characteristic of which the nuclei are wholly devoid, and further, because in animals, and probably also in plants,† several such utricles are sometimes formed in one cell.

It is no proof of the spermatic utricles being cells, that in the Florideæ, Mosses, and Ferns, they are applied closely together so as to form an apparent tissue; since it is quite as possible as not, that they are produced in one large cell resembling an embryo-sac, or that the cells in which they are formed become dissolved.

* Page 107.

† Nägeli on the Propagation of the Rhizocarpeæ; Zeitschr. für wiss. Botanik, H. 3, p. 188 (1846).

The mode of origin of the spermatic cellules is unknown, as also of the propagation.

The shape of the spermatic utricles is globular or ellipsoidal when they are free—parenchymatous when they are closely packed together.

The contents are originally homogeneous and mucilaginous. In this may be perceived globular utricles or solid corpuscles, probably analogues of the nucleoli of the nuclear utricle. Sometimes the homogeneous contents subsequently become finely granular. Chlorophyll-granules are occasionally formed in them. In the Rhizocarpeæ* they also contain starch-globules (?). At a later epoch a spermatic filament,† composed of albumen, is produced in each of these utricles.

3. *Nucleoli* (Kernchen).

The nucleoli were formerly regarded as solid bodies. I have already remarked upon this, some time ago, that certain phenomena connect themselves readily with the hypothesis that they are utricles.‡ The question is now, whether there are grounds for this assumption.

That the nucleoli are not mere aggregations of mucilage, follows from the circumstance that they always present themselves with a very definite border. Moreover, it is sometimes possible distinctly to perceive on them a membrane different from the contents. The contents are not always solid; they frequently exhibit one or more cavities; they are even frothy and granular, like the contents of the nuclear utricles and the cells. To these we may add the analogy with animal nucleoli, which are likewise utricles, and the other utricular structures of the cell-contents.

* Nägeli on Rhizocarpeæ, loc. cit.

† Nägeli on the Moving Spiral Filaments (spermatic filaments) in Ferns. (*Bewegliche Spiralfaden*, &c.) Schleiden u. Nägeli's Zeitschrift f. wiss. Bot., Heft i, p. 174 (1844).

‡ Nägeli on Cells, &c.; Ray Translation, 1845, p. 250.

The nucleoli occur inside the nuclear utricles and the spermatic utricles.* Nothing is known of their mode of origin. In animal nucleoli a process of division has been observed.†

The shape of the nucleoli is globular; at the moment when they originate by division, hemispherical. If they lie upon the membrane of the nuclear utricle, they are sometimes flattened on that side. The contents of the nucleoli are originally homogeneous and mucilaginous, and usually exhibit greater density than those of the nuclear or spermatic utricles; in rare cases they are less dense, causing the nucleolus to appear like a hollow space. The homogeneous contents of the nucleolus subsequently become frothy and granular; or they remain homogeneous and exhibit one or more cavities.

4. *Mucilage-* (*Protoplasm-*) *utricles* (Schleimbläschen).‡

These structures have hitherto been either overlooked, or taken for large mucilaginous granules or for globules of agglomerated mucilage. They may be seen beautifully, and in great abundance, in the Characeæ, where, together with amorphous masses of mucilage, they are the chief bodies seen to rotate. I have also seen them in the cells of many Algæ, of the leaves of Mosses and Hepaticæ, in the Ferns and the Phanerogamia. They do not present themselves constantly, and mostly but sparingly, 1—6 in a cell. They are more certain to be found in large cells than in small.

The mucilage-utricles are distinguished from the mucilaginous granules by their much more considerable size, by possessing a perfectly spherical shape and a smooth surface, and by refracting light less. That they are utricles,

* Nägeli on Cells, &c.; Ray Translation, 1845, pl. vii, fig. 11 *a*. Nägeli on Moving Filaments, &c., loc. cit. pl. iv, fig. 16, *a*, *b*, *c*.

† Kölliker, Entwick. der Cephalopoden, pl. vi, fig. 68.

‡ I refer the reader to the observation made in the preceding essay (p. 124) on the term "mucilage" (*schleim*).

and not homogeneous granules, follows from this:—1st, that when large enough, a membrane may be detected on them which is not coloured by iodine, while the contents become brown (pl. II, fig. 18); and 2d, that the mucilaginous contents may become frothy and hollow. The membrane becomes especially manifest, when the contracting contents separate in places from the membrane, in utricles which come in contact with water or tincture of iodine (fig. 18, *b*, *c*).

Little can be observed of the origin of the mucilage-utricles. They first appear as very minute globules of mucilage. It is possible that a small quantity of mucilage becomes agglomerated, individualized, and acquires a membranous covering. I have not observed a propagation of the mucilage-utricles.

The shape of the mucilage-utricles is spherical from the beginning, and it always remains so. The growth serves merely to expand the utricles uniformly.

The contents are originally homogeneous. They remain in this condition, or one or more hollow spaces appear in them.

The membrane is delicate, and seldom attains any considerable thickness. In *Chara* and *Nitella* only have I yet seen the mucilage-utricles with tougher membranes. The membrane is also thin here originally, and either invisible or only indistinct. By the application of iodine we may mostly succeed in seeing it more clearly. It then appears distinctly bordered by two lines (Fig. 18, *a*). At a later period minute points (*b*) appear on the outer surface, which with the increase of size show themselves to be little spines (*c*, *e*). In old utricles the spines disappear, and the outer surface of the membrane is irregular and uneven (*d*). During this the membrane has been constantly increasing in thickness.

Looking for an analogy for the spines just described, one might think of the cilia of the germ-cells of *Vaucheria*, and notice that the mucilage-utricles of the Characeæ likewise move (rotate), while the mucilage-utricles of other

plants have not this property. But the objection here applies that the mucilage-utricles rotate already before the spinous coat is observable on them. I do not think, therefore, that this has anything to do with the motion, and would rather conjecture that it is to be explained in the same way as the outer membrane of the pollen-granule.

5. *Proliferous utricles* (Brutbläschen.)

I give this name to those utricles in which, as in *Caulerpa*, the chlorophyll- and starch-granules originate.* I formerly called them "mucilage-cellules" (*schleimzellchen*), but this name now requires alteration in respect to the rest of the nomenclature. Mettenius† saw the proliferous utricles in the radical hairs, and in the hairs of the upper surface of the leaf in *Salvinia*.

According to Hartig‡ the chlorophyll-granules originate in the so-called *euchrome-cells*, one kind of the so-called *ptychodal utricles*. The manner in which the researches were instituted, however, does not appear to me to afford the requisite guarantee, for results which can be depended on. It therefore still remains uncertain whether and where the proliferous utricles are found in the Phanerogamia.

The proliferous utricles first appear as homogeneous globules of mucilage. When they become larger, we detect a membrane on them, and mucilaginous contents, coloured yellow or brown by iodine. According to Mettenius, the utricles originate as minute amorphous granules. If this be intended to signify those minute homogeneous globules of mucilage, and not actual granules, it agrees with my observations. The globules differ from the mucilaginous granules by their regular, perfectly spherical form, their wholly smooth surface, and

* Nägeli on *Caulerpa*, Zeitschr. für wiss. Botanik., Heft i, pp. 184, 190.
† Beiträge zur Kenntniss der Rhizocarpeen, p. 51, pl. ii, figs. 42, 43.
‡ Das Leben der Pflanzenzelle, pp. 8-10.

the smaller power of refracting light. The exact process of the origin of the proliferous utricles is as yet unknown. Perhaps minute portions of the homogeneous mucilage of the cell become individualized, acquire a globular shape, and produce a membrane on their surface. Propagation has not yet been observed in the proliferous utricles.

The proliferous utricles lie free in the contents of their cell, and are always of globular shape. They increase in size up to a certain point.

The contents of the proliferous utricles at first consist of homogeneous mucilage; this frequently becomes granular. In it originate several globules of starch- or chlorophyll-granules.* The membrane of the proliferous utricles is subsequently dissolved, and the starch-globules and chlorophyll granules lie free in the cavity of the cell.

6. *Colour-utricles* (Farbbläschen).

These include the chlorophyll-granules, and the other coloured globules of the cell-sap. They have already here and there been called utricles, but no membrane has been shown to exist upon them. Formerly, the starch-globule, mostly present in their interior, was frequently taken for a cavity.

The following facts prove that the said structures are actually utricles: a whitish membrane, surrounding the green contents, may be clearly seen in the larger chlorophyll-utricles of the Algæ, of the leaves of Mosses, of the pro-embryo of Ferns (pl. II, fig. 10 *a*, *b*, *c*), of Characeæ (fig. 17), and, in favorable cases, in the leaves of Phanerogamia (fig. 12 *a*—*l*). When they lie close together, they do not become blended into a mass, but, like cells, acquire a parenchymatous form (fig. 11). By abnormal alteration (in the pro-embryo of Ferns (fig. 10 *d*, *e*, *f*), in the leaves of Mosses and Hepaticæ), they become

* On *Caulerpa prolifera*, by C. Nägeli; Zeitschrift. f. wiss. Bot., Heft i, 1844, pl. iii, fig. 19.

larger; the contents lose their colour, and pass into a colourless fluid containing granules; in this condition they are undistinguishable from minute cells. The contents of the chlorophyll-utricles undergo peculiar changes, which chiefly consist in the origin of one or more starch-globules (fig. 12). Green and red colour-vesicles manifest growth, and in the course of this their shape is altered in various ways. Finally, the chlorophyll-utricles divide like cells (fig. 10 *c*).

Since Mohl's researches* the chlorophyll-utricles have commonly been regarded as a nucleus of one or more starch-granules, on which chlorophyll has been deposited as a coating. This view presupposes that the starch-granules exist first, and that they are afterwards coated with chlorophyll. But the transition of starch-globules into chlorophyll-granules has nowhere been seen. On the other hand, chlorophyll-utricles not unfrequently occur in the Algæ without a trace of starch in their interior. In some Algæ, moreover, as well as in higher plants, the origin and growth of the starch-globules may be traced, in the interior of the chlorophyll-utricles, up to the absorption of these latter.

The colour-utricles are best named according to their colour; green, red, blue, or yellow colour-utricles, or even with one word; green utricles (chlorophyll-utricles), red utricles, &c.

I know nothing of the origin of colour-utricles free in the cell-contents. They appear as minute (green or red) granules, which, after they have reached a sufficient size, display an utricular structure (fig. 10, *a*, *b*; fig. 12; fig. 17). They originate by the division of a parent-utricle. This becomes elongated, divides by a wall, and separates into two new colour-utricles (fig. 10 *c*).

I have seen the division of the green colour-utricles in Algæ (e. g. in *Bryopsis Balbisiana*, *Valonia ovalis*), in the pro-embryo of Ferns, and in *Nitella*. This division sometimes presents such an appearance that we only see

* Untersuchung. üb. die Anatom. Verhältnisse des Chlorophylls. (Dissertation, 1837, Verm. Schrift. p. 349.)

a circular constriction, which advances inwards, and at last parts the chlorophyll-utricle into two. In other cases a septum is first perceived, and the apparent constriction is recognised to be simply a result of the retraction of the already-formed secondary utricles from each other. Thus a conviction is readily attained that in the first case the septum is overlooked on account of its delicacy, or its oblique position.

It may, indeed, be objected that the said division is merely apparent, and produced artificially by the close apposition of two colour-utricles. Such a condition is actually produced artificially, when two utricles come so close together under the microscope, that they become flattened by their mutual pressure. It is therefore a question whether to take account of that apparent division of the chlorophyll-utricle in the vegetable-cell, or not. *Nitella* has furnished me with evidence for it.

I examined the terminal cell of the leaves in various stages of growth in the same individual, in *Nitella syncarpa*, namely, 1st, one measuring ·080 of a line; 2d, one = ·500; 3d, one = 1·5; and 4th, one = 6 lines in length. The diameters were from ·030 to ·050, ·060, and ·090 of a line. The chlorophyll-utricles lay in vertical rows on the walls. They were all of about equal size, and exhibited a perfectly regular shape, both in the young and in the old cells. Some appeared to be in the commencement of the act of division. Actual division and propagation must take place if the number of chlorophyll-utricles increase from the young to the old cells, since of any very minute utricles which might originate free among the others, I saw no trace, either between the utricles of the same row, or between the rows. Now I counted the rows, and found constantly about eighty of them, both in the young and old cells. No multiplication of the rows takes place; in fact I did not see any chlorophyll-utricle divide perpendicularly into two utricles lying side by side. On the contrary, I found in the first and shortest of the four cells mentioned, 40 utricles in a row;

in the second cell, 150; in the third, 500; and in the fourth, and longest cell, 2000. During the growth of the cell from a length = ·080 of a line to 6 lines, the number of chlorophyll-utricles had increased in each row from 40 to 2000, and in the whole cell from 3200 to 160,000. Consequently, while the cell became seventy-five times longer, the chorophyll-utricles increased about fiftyfold.

I found the like in the cells of the stem of the same plant. In a length of 1·3, and a diameter of ·14 of a line, I counted about 160 rows, in each row about 325 utricles; in one about 20 lines long and ·2 in diameter, again about 160 rows, but some 3500 utricles in each row; and lastly, in a cell 30 lines long, and of a diameter = ·24, I found about 160 rows, and some 6700 chlorophyll-utricles in each row. Here also the utricles were of tolerably equal size, and in regular arrangement in the cell. Individuals exhibited transverse division; but I saw no young, minute utricles between the others, so that here also *the increase in number could only be effected by division.* This increase amounted to about twenty times the number, while the cell increased about twenty-three times in length.

If the colour-utricles originate free in the cell-contents, their shape is at first globular; if they are produced by the division of a parent-utricle, at first hemispherical or semi-ellipsoidal. In the latter case they soon assume a globular form as they separate from each other. If the utricles, as rarely happens, remain free, so that they swim in the cell-contents, they retain their globular form. Usually they apply themselves upon the wall, whereby their form is more or less altered, since they become more or less flattened. Their section is then either almost round, oval, hemispherical, semi-elliptical, or flatly compressed.

The alteration of form which the colour-utricles undergo during their growth consists not only of a mere flattening of greater or less extent, which we see in the side view

(or section), but also in the acquirement of a different shape, as seen in front. Here also the utricles at first appear round. They either remain round or become elliptical. If they lie close together, they become parenchymatous (fig. 11, fig. 13). If colour-utricles increase in length, this takes place either parallel to the long axis of the cell, or if they lie in a circulation thread, in the direction of the current. I have observed the latter in the Algæ (e. g. in *Conferva glomerata marina*). On the inner surface of the cell-wall lies a network of mucilaginous filaments. The chlorophyll-utricles form simple rows in the lines of the reticulation (fig. 16). They extend in length in the direction of the lines, and may become lanceolate, or even linear. Those lying in the angles of the network assume a triangular form; the angles are more or less drawn out in the direction of the filaments of circulation towards which they are turned. In Florideæ (e.g. in *Ceramium diaphanum*) I saw the red utricles, which were originally round, elongate so much in the direction of the longitudinal diameter of the cell, that they had the appearance of long fibres. In this case their transverse diameter diminished considerably.

The growth of the colour-utricles presents great similarity to the universal growth of cells. It exhibits on the one side the transition from the globular to the tabular form, on the other from the globular to the elongated, fusiform or filamentous shape. They may also become elongated into separate processes, almost like stellate cells. Moreover, by pressure they may become parenchymatous.

The expansion which is connected with the growth of the colour-utricles exhibits great quantitative differences. It is greatest in those which originate free in the cell-contents, since they appear first as very minute granules. It is less in those which have been produced by the division of a parent-utricle; here it amounts, as a rule, to two to three times the original length and breadth; otherwise the growth is not always connected with an increase of size in all diameters; in tabular and very much flattened

chlorophyll-utricles, the smallest diameter is shorter than it was at first; in the thin, fibre-like red utricles both the shorter diameters are very considerably diminished.

The contents of the colour-utricles are at first always homogeneous, green (fig. 12 *a*; 13 *a*), red, yellow, or blue. They may present different characters during the life of the utricle.

In the first place, the contents remain for the whole period homogeneous and coloured, without alteration, or at least without any that can be noticed.

Or, secondly, one or more very minute granules become visible in the contents, which are permanent in this stage, and the nature of which cannot be made out, on account of the small size. Probably they are starch-globules, as would result from the following. In a third condition of the contents, minute granules of the same kind appear, but are somewhat larger, and appear as whitish globules, coloured violet or blue by iodine (fig. 10, *a*, *b*, *c*; fig. 11; fig. 13; fig. 17). Mohl thinks that the violet tinge is produced by the brown colouring of the surrounding green contents. It appears certain to me, however, that this is proper to the starch-globules. Even before the treatment with iodine a difference is observable in the latter, for they refract light more strongly and the others more weakly. If they refract light in this manner, they will acquire the blue colour, in spite of the surrounding chlorophyll; if the refraction is less, the colour is violet. These starch-globules are very frequently solitary in an utricle; sometimes, however, from two to five are present. They only occupy a small portion of the cavity of the utricle.

A third condition of the contents consists in the following: As before, minute granules first become visible in the homogeneous, coloured contents. They increase in size, and at last almost wholly fill the utricles, so that merely a thin layer of colour remains investing the starch-globule (fig. 12 *i*). If, as is generally the case here, the membrane of the utricle is indistinct, it appears as though

the starch-globule were only coated with colouring matter (chlorophyll).

A fifth condition. One or more starch-globules originate in the colouring matter (fig. 12, *a*—*f*), which increase in size, and finally almost fill the utricle (fig. 12, *g*—*l*). The colouring matter (chlorophyll) by degrees vanishes, at last entirely, and finally the membrane also of the utricle is dissolved, and the starch-globules lie free in the cell (fig. 12, *m*, *n*).

These are the principal alterations which take place in the contents of the colour-utricles. I have chiefly observed them in chlorophyll-utricles. Nothing general can be said respecting the distribution of the forms mentioned. As a rule, all or many are met with in the same Natural Order. I have, however, met with green utricles with contents remaining homogeneous, and those minute starch-globules, coloured blue by iodine, much more frequently in the Algæ and Mosses; those with large starch-globules, coloured blue by iodine, more frequently in the higher plants. The red-utricles of the Florideæ generally exhibit only homogeneous red contents. The yellow and blue utricles I am not yet sufficiently acquainted with.

It still remains to be noticed that globules occur, in rare instances, in the place of the starch, inside the colour-utricles, which are either not coloured at all by iodine, or become yellow. In my opinion they are composed of a substance analogous to starch; allied to gelatine and inuline. But I cannot agree with Schleiden, who says, that chlorophyll (the chlorophyll-globules) often invests starch, and also often other substances.* Beyond starch (as ordinarily), and the globules just mentioned (which occur exceptionally), I have never yet met with any known solid product in the chlorophyll-utricles, for instance, not even oil- or mucilage-granules, &c.

The homogeneous colouring matter of the colour-utri-

* Grundzüge, 2d ed. i, p. 190.

cles also undergoes an alteration occasionally, consisting in the colour becoming fainter; moreover, even in the transition of one colour into another. In many genera of Florideæ it is rather common for the red colour-utricles to become subsequently green or yellowish green.

The colour-utricles undergo dissolution in three ways: 1, by propagation; 2, by the starch-globules inclosed within them gradually displacing the colouring matter, and at length causing the absorption of the membrane; and, 3, by changes in the cell-contents, inducing a solution of the contents and membrane.

When the solution of the colour-utricles is brought about by changes in the cell-contents, they usually become detached from the cell-wall, pass into the interior of the cavity of the cell, and acquire a more or less perfectly globular form. The colouring matter becomes granular, loses its colour, and is then dissolved, the membrane at the same time disappearing. In decaying cells of the pro-embryo of the Ferns, as well as occasionally in decaying cells of the leaves of the Hepaticæ and Mosses, I have seen the chlorophyll-utricles expand considerably during this process (in *Pteris nemoralis* from ·006 to ·008 of a line). The chlorophyll dissolved into minute dark granules which swam in a colourless fluid. The membrane of the utricle was here very distinct. (Fig. 10, *d*, *e*, *f*.)

7. *Starch-utricles, Starch-granules.*

Three different opinions have been expressed as to the origin and nature of the starch-granules. According to one, they consist of a cell-like envelope and fluid contents. According to a second, a nucleus is first formed, around which concentric layers are deposited on the outside. According to a third view, the formation of the layers proceeds from without inwards.

The first opinion, Raspail's, appears in a peculiar form, resulting from his theory of cells. The starch-grain is a

cell or an utricle originally attached to the wall of the cell, and produced by this. The envelope is starch; the contents gummy (gummös) and semifluid. Microscopic investigation is in opposition to this view.

The second opinion, as champions of which Fritsche and Schleiden may be named, maintain, on chemical grounds, the fundamental point, that, with the exception of the nucleus, the layers are wholly composed of the same chemical substance. The outermost layers are impregnated with foreign matters, and are thus rendered insoluble in water. Especial difficulties occur in this view, both in chemical and physiological respects, in explaining the nucleus, which, according to the authors mentioned, on one hand, is a hollow space, on the other, contains neither sugar, gum, nor starch. What then is the thing upon which the first and innermost layer of starch is deposited.

The third opinion has been recently promulgated by Munter.* The innermost layers are the softest, and thus the youngest. Very good; but the origin of the outermost and earliest layers of starch is here forgotten; upon what are these deposited? Of course there is no difficulty about those succeeding. Moreover, a fact which Munter states that he has ascertained in the starch-grains of *Gloriosa superba*, stands in strange contradiction to this view, namely, "that an organic compound also may appear in a crystalline form;" and then the term of "starch-concretions" (*stärkedrusen*) proposed for these so-called agglomerated granules is just as inapplicable.

In my opinion, the starch-grains are utricles, and consist, like the other utricles, of a membrane and fluid contents. Concentric layers are deposited on the inside of the membrane as in lignifying cells. The cavity of the utricle (the so-called nucleus) thus becomes reduced to a most minute excavation, which is always filled with fluid.

* Botanische Zeitung, 1845, p. 193.

The grounds for the opinion here expressed are as follows: In many starch-grains a layer different from the rest, and surrounding the nucleus, may be more or less clearly perceived. In some, this shows itself as a tolerably thick membrane which iodine does not colour (fig. 14). The starch-grains are hollow; sometimes the cavity is so large that the starch invests the membrane merely as a thin layer (fig. 15). The layers become softer and contain more water toward the interior, and are tougher and more solid toward the exterior; from analogy to the lignifying layers of cells, the softer are to be considered as the younger, the harder the older.

Nothing is known of the origin and propagation of the starch-utricles, except what regards the external conditions under which they are produced; we know that they may be formed free in the cell, and this either in mucilage or in chlorophyll; in utricles, namely, in the interior of nuclear utricles (in the Fucoideæ*), of prolific utricles (*Caulerpa*), and of colour-utricles (pl. II, fig. 10, 11, 12, 13, 17).

The shape in which the starch-utricles appear is probably at first always spherical. They may remain spherical or extend lengthways, so as to become almost cylindrical, or grow in a plane, so as to assume a tabular shape. The form of the full-grown starch-grains is exceedingly varied and mostly irregular, so, however, that granules which originate free, are always bounded by one single curved surface.

The granules lie free or united in groups of from two to twelve, and even more. A group of this kind is, not very aptly, termed a compound grain. The individual grains or utricles are parenchymatous; the sides directed towards the interior of the group are plane, those which form the surface of it are curved (convex outwards). All the grains united together in a single heap have been produced in one utricle. They are at first spherical, but from the reciprocal pressure which they undergo, in consequence of their growth, they acquire a parenchymatous

* Nägeli on Cell-Formation; Part I, Ray Trans. 1845, pl. vi, fig. 16.

form, and through this same pressure adhere together as a tissue (fig. 12 *g*). If the utricle then becomes absorbed, the grains either remain united in a group (fig. 12 *n*) or separate. Since, however, they have acquired a solid structure by the formation of layers of lignification, they do not reassume the globular form, but remain polygonal and exhibit a shape which has a crystalline appearance, without, on that account, being actually crystals (fig. 14).

I do not mean, however, that the starch-grains which have originated together in the same utricle, necessarily always assume a parenchymatous shape; they only do this when they are contained in proportionate number or size (to the size of the utricle). If they lie more loosely in the utricle, they always remain isolated and retain their rounded surface. Thus I have never seen starch-grains become properly parenchymatous, either in the nuclear or prolific utricles. In the green utricles, also, I have likewise often seen them remain globular, even when a number have originated together in one utricle.

Those starch-grains, therefore, which lie separate and are bounded by a single curved surface, have originated either free in the cell, isolated in utricles, or in numbers loosely arranged in utricles. Those which lie separate and have one or more plane surfaces or angles, have originated in numbers, closely packed in a green utricle.

In like manner the granules united into a mass have been formed together in a green utricle.

The original contents of the starch-utricles are unknown. As soon as they have attained a sufficient size to allow of their being investigated, they are coloured blue, violet, or red, by iodine. The formation of layers, therefore, begins very early, and it must thence be assumed that the outermost and first layers expand considerably in surface until the growth of the utricle is completed. There is nothing whatever opposed to this hypothesis, since the layers are at first in a soft, semifluid condition, and since the cell-membranes and the earliest of its layers of thickening are likewise capable of considerable expansion.

Consequently starch-utricles and cells agree in this: that

the membrane of both begins to be thickened soon after its production. They are distinguished by the fact that in the starch-utricles this thickening is relatively much more considerable, even at the very beginning, than in the cell.

The structure of the starch-utricles first becomes clear when they have acquired a greater size; this is: a membrane, probably composed of gelatine, layers formed of starch, and a cavity filled with watery fluid. The membrane is more or less distinct; when it is thick enough we may perceive that it remains uncoloured in the treatment with iodine, while the layers become blue or violet (fig. 14, 15).

The layers are formed like the thickening layers of the cell; the concentric lines are to be explained in the same way as these. The layers are composed of starch throughout their entire thickness. They decrease in solidity from without inward, and contain more water in the reversed order. Hot water and acids cause them to swell up very much, and they frequently tear in consequence of an unequal expansion, either merely in the interior, or from within outward. But that an air-bubble originates in the cavity through the action of sulphuric acid, as has been asserted, I have not seen, neither can I conceive how sulphuric acid could produce an air-bubble here, by abstraction of water. For the acid does not draw out the water like some pump or exhausting apparatus, but when the acid is applied to the starch-grain a reciprocation of currents is set up, according to the law of endosmosis and exosmosis, through the layers and the membrane, the acid passing in, and a portion of the fluid of the cavity and the layers going out. If more fluid passed out than in, and the starch-utricle could not contract in a corresponding degree, the only consequence would be that the diminution of density, beginning in the interior, would cause an increased flow inwards from without. Now the swelling up of the utricle proves exactly the contrary, namely, that more fluid passes in than out.

The cavity of the starch-utricle is sometimes larger, sometimes smaller. In a given size of the utricle of

course its size is in inverse proportion to the thickness of the layers. In many grains the cavity is reduced to a minimum. These grains correspond to the cells of the stony concretions of pears, and completely lignified liber-cells. In other grains the cavity is of considerable size. The thickness of the deposited layer of starch may be so small that the starch-utricle resembles a cell with moderately-thickened walls (fig. 15). I found such a condition not unfrequently in the pith and rind of the fruit panicle of *Vitis*. The cavity is filled with an almost colourless fluid, which doubtless is no simple chemical substance, but contains formative matter, such as gum, sugar, and quaternary compounds, although in small quantity.

8. *General Retrospect.*

We have found various organic structures in the cell-contents possessing, in all their phenomena, a great resemblance to the cell itself. The general term for those structures, partly on account of this similarity, partly to express the actual difference, may most fitly be *utricle.*

The utricle agrees with the cell* in the following characters. *It probably originates by the isolation of a (minute) portion of organic substance, which becomes coated with a membrane. Therefore from the very origin there appears a distinction between contents and membrane. The utricle grows both in its membrane and its contents, and, in the course of this, changes its shape in manifold ways. The membrane expands and becomes thickened by the deposition of layers in the interior. The contents are metamorphosed, and produce new organic forms. Finally, the utricle propagates.*

Thus nothing occurs to the cell which is not found in the utricle, at least in one or a portion of the kinds of utricle. Moreover, we see that exactly the essential peculiarities of the cell, *the proper membrane and the transformable contents,* occur in all utricles. The identity between cell and utricle is, therefore, tolerably manifest.

* See the preceding Essay (on Cell-Formation).

The *distinction* between the two is more difficult to find, especially because the origin of the utricle is not yet sufficiently made out. I believe, however, that even with our present knowledge, the distinction may be at least so far established, that cell and utricle appear as absolute, distinct conceptions. The comparison may take into consideration either the relation of the two structures to the individual plant, or the two structures independently of general relations.

In reference to the relation to the vegetable organism, cell and utricle exhibit the following distinction. The cell is the elementary organ, which takes part *immediately* in the formation of a tissue. The plant first becomes independent with the cell. It developes through the formation and growth of cells; it lives through the cells. The utricle, on the other hand, is an elementary organ which takes part only *mediately* in the origin, structure, and life of the plant, because the utricle is merely a part of the cell. Consequently we may call the cell the *immediate*, the utricle the *mediate* elementary organ of the plant.

Considering cell and utricle independently, as individual organisms, we can at present establish merely the following distinction. The cell needs for its production a nucleus, formed previously; it is formed around a portion of organic cell-contents in which a nucleus is inclosed.* The utricles, on the contrary, never originate around a nucleus, only the nuclear utricles originate around a nucleolus. We may accordingly define the cell and the utricle in the following terms:

The cell is an individual quantity of contents, inclosed by a homogeneous membrane, and individualized through the influence of a nuclear utricle; it is the immediate elementary organ of the vegetable organism.

The utricle is an individual quantity of contents, in-

* I have shown, in the preceding Essay, that in the first place a nucleus is produced which individualizes a greater or smaller quantity of the surrounding contents, through attraction, and that this individualized portion of contents acquires a membranous coat upon its surface.

closed by a homogeneous membrane, and individualized without the influence of a nuclear utricle; it is merely the mediate elementary organ of the vegetable organism.

The following kinds of utricle may be distinguished:

1. *Nuclear utricle, Nucleus. It originates under the influence of a nucleolus, and contains, at least in the earlier periods of its life, scarcely anything, excepting one or more nucleoli* (*colourless* or *coloured*), *besides mucilage. It occurs* (with the exception of those which originate in a parent-cell) *only immediately in the cell* (not in another utricle).

2. *Spermatic utricle. It originates*, probably, like the nuclear utricle, in like manner, *under the influence of a nucleolus. It contains principally mucilage, and produces a spermatic filament in its interior.* The spermatic utricle probably occurs originally merely in cells, and in any case never inside other utricles.

3. *Nucleolus. It contains mucilage, and occurs* (sometimes with the exception of those around which the nuclear utricle has not yet been formed) *only inside the nuclear utricle.*

4. *Mucilage-utricle. It contains mucilage, but no nucleolus, and occurs immediately in the cell* (not in other utricles).

5. *Proliferous utricle. It at first contains mucilage, but no nucleolus, subsequently colour- or starch-utricles, which, after its solution, become free.* It occurs only free in the cell (not in other utricles).

6. *Colour-utricle. It contains colouring matter, but no nucleolus,* and may be named according to the colour. It frequently contains also starch-utricles. It occurs free in the cell as well as in old nuclear and proliferous utricles.

7. *Starch-utricle, starch-granule. It contains layers of thickening of deposited starch,* and occurs free in the cells, as well as in old nuclear, colour, and proliferous utricles.

ANNUAL REPORT

ON RESEARCHES IN

PHYSIOLOGICAL BOTANY,

DURING THE YEARS 1844 AND 1845.

Heinrich Friedrich

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PHYSIOLOGICAL BOTANY.

GENERAL OBSERVATIONS.

Physiology, and with it Physiological Botany, were, it was thought, quietly making considerable progress, since the number of contributors continually increased, and though of course opinions differed, none were maintained with any remarkable violence. Then certain individuals appeared who endeavoured to disturb this tranquillity, and not only advocated their own opinions with great violence, but attacked those who thought differently, challenged them, and even in some cases insulted them. I shall especially mention three of these—Liebig, Gaudichaud, and Schleiden. All three write well, Liebig excellently so; not one is wanting in genius and ingenuity; in their zeal, however, they have not all been able to command themselves, but have given way to a violence which, although not hindering them for any time, perhaps even aiding them in acquiring speedy renown, is nevertheless always injurious to the cause which they are anxious to advocate.

Liebig says, in the first edition of his celebrated book, 'Organic Chemistry in its Application to Agriculture and Physiology' (Brunswick, 1840), p. 35, "As soon as physiologists meet with the mysterious vital force in any phenomenon, they renounce their senses and faculties; the eye, the understanding, the judgment, and the reflective faculties, all are paralysed as soon as a phenomenon is declared to be incomprehensible." Now this has not really been the case; they have indeed very

rarely declared a phenomenon to be incomprehensible, whilst they have frequently erred in the contrary direction; but supposing they had done so, they could always say confidently to those philosophers who wish to believe that everything depends upon mechanics, and forces which act mechanically—"Tell us, ye slanderers, are you then acquainted with the fundamental theory of the whole of your mechanics; do you understand the cause of motion even in the slightest degree? Is it not the most incomprehensible of all the phenomena with which we are surrounded?" And even if it were answered that it was the first, the most common, and the most certain empirical knowledge upon which anything could be based with certainty, it might be easily replied, that the same was also the case with vitality, for we cannot even start the question of the cause of motion without living. What has just been stated might be recommended to many philosophers, especially in foreign countries, as a subject for careful consideration, when they urge mechanical explanations to the very utmost—when, as it were, they are suspended in the air without any support. Dutrochet may serve as an example; he attempts to explain mechanically all the motions of plants, by means of endosmose and exosmose, by the influx and egress of the fluids in the cells and vessels which permeate the membranes, fill and distend the cells, and produce movements by means of this distension, and even by flowing out produce collapse and motion in the opposite direction. Yet the causes of the phenomena of endosmose and exosmose, upon which this theory is based, have by no means been ascertained; it has certainly not been proved that the exchange of matters in solution through the unvitalised membrane, which we find in these experiments, occurs through the living membrane of the cells in plants, for the simple reason, that we do not find that those cells which are situated near each other contain different fluids, by means of which this exchange could be effected; we cannot understand how the gradual influx and egress

occurring in endosmosis and exosmosis can produce rapid movements, especially those of *Mimosa pudica*, to which Dutrochet applies his theory; lastly, it cannot be explained by mechanical laws how this expansion and contraction of the cells becomes capable of raising whole portions of plants. Still this is repeated by the majority, and De Candolle was once at their head; but I must cease here, to avoid falling into the very error that I have attributed to others.

Is it not better, instead of retarding the progress of science by such explanations and their details, to recur at once to a vital force, the determination of the laws of which will remain our object, and our not unfounded hope?

To a certain extent, but to a certain extent only, has Liebig returned to the ordinary path in regard to the vital force. In his book, 'Organic Chemistry in its Application to Physiology and Pathology' (translated by Dr. Gregory, London, 1842), in the third part, speaking of the phenomena of motion in the animal organism (p. 196), he says: "If the vital phenomena be considered as manifestations of a peculiar force, then the effects of this force must be regulated by certain laws, which laws may be investigated; and these laws must be in harmony with the universal laws of resistance and motion, which preserve in their courses the worlds of our own and other systems, and which also determine changes of form and structure in material bodies, altogether independently of the matter in which vital activity appears to reside, or of the form in which vitality is manifested." The author is by no means clear in his views of the pretended vital force. What is meant by "must be in harmony?" Are they the same, or do they only resemble each other? We do not see why they might not be directly opposed, or totally different. But the author's views are not clear even upon a purely physical force, the attraction of gravitation. He says (l. c. p. 201): "If it (the stone) fall from a certain height, it makes a permanent impression on the spot on which it falls; if it fall from a still

greater height (during a longer time), it perforates the table; its own motion is communicated to a certain number of the particles of the wood, which now fall along with the stone itself. The stone, while at rest, possessed none of these properties. The velocity of the falling body is always the effect of the moving force, and is, *cæteris paribus*, proportional to the attraction of gravitation. A body falling freely acquires, at the end of one second, a velocity of 30 feet. The same body, if falling on the moon, would acquire, in one second, only a velocity of $\frac{30}{3600}$ths of a foot, $=0{\cdot}1$ inch, because in the moon, the intensity of gravitation (the pressure acting on the body, the moving power) is 3600 times less."

We shall not dwell upon the individual expressions which are not always accurately applied, but shall merely ask, Why does Liebig omit to notice the law of inertia, upon which all mechanical determinations are based, which causes the velocity of a falling body to increase constantly in proportion to the duration of its fall. Galileo applied it without recognising it; when he discovered the law, that the space through which a body falls is as the square of the time in which it falls. Newton called it the law of inertia, placed it at the head of his 'Principia Philosophiæ Naturalis Mathematica,' and expressed it as follows: "A body continues in its state of rest or motion, in the same direction and with the same velocity, until some motive force compels it to change this state." It may be perhaps attributed to the physio-philosophers of Germany that they have forgotten, or at least overlooked, this law in the explanation of natural phenomena; in fact, that natural philosophers, who, like Liebig, have no respect for philosophy, make no mention of this law. Not only does it explain the increased velocity acquired by a falling body, but even the most common, the daily phenomena occurring upon the moving globe, could not be explained without it—such, e. g. as the fall of a stone from a house or a tower; why, when allowed to fall from the west side of a house it does not reach the earth

far behind the house; because the house being situated upon the globe, which is in rapid motion, flies away as it were from it; and lastly why, when a stone falls from a high tower, a deviation ensues, because the summit of the tower is in more rapid motion than the earth at its foot, towards which the stone descends. But I feel ashamed to be teaching matters which belong to elementary school-instruction. Newton correctly ascribed to matter inertia, and not a property of passive resistance, as some philosophers attribute to it; for so long as the matter is subjected to this law, it has no property; it is in a perfect state of indifference; it cannot assume a state of motion when at rest; it cannot, in the slightest degree, alter any motion which has been imparted to it from without, and without its co-operation; in short, if we may use the expression, it is lifeless. Here, then, we have a certain and definite character of inactivity, from which we may start, and from which we must start, in the consideration of vitality and the vital force. The antithesis of vitality, in contrast with this state of inertia, this indifference, is clear; a body must be called living when capable of spontaneously assuming a state of motion from one of rest, or when capable of changing or in any way determining its motion; whence what is to be considered as the vital force soon follows. Let us take one application of what we have stated: Is the universal attractive force a vital force? The answer is negative; the body approximates to another, merely inasmuch as it is attracted; it does not then set itself in motion; it does not determine its motion by any power of its own; this is merely determined by the attraction of some other body. Hence alone is astronomy enabled to calculate with certainty and accuracy the motions of the celestial bodies. This force can certainly set other bodies in motion, but not that body in which it exists, and through which it acts. We cannot in any way understand why there should not be forces capable of setting the bodies in which they exist in motion, since we find motions in living bodies which

cannot be derived from external forces. These are denominated vital forces. They are not in the least more incomprehensible than the force of attraction; in fact they are less so. Newton found, with regard to the force of attraction, that the intensity with which it acts upon a body is inversely proportional to the square of the distance of the body from the centre of attraction. But has this law been shown to exist in the case of other forces? Does it apply to cohesion, elasticity, magnetism, &c.?

Liebig says, in his 'Chemical Letters' (Heidelberg, 1844, p. 18), "Medical writers and kindred minds are annoyed at the great simplicity of the truth, although they have not succeeded in practically applying it, notwithstanding all their pains; they therefore give us the most improbable views, and by the term vital force they understand a wonderful thing, by means of which they explain everything which they do not understand; by a thoroughly incomprehensible and indefinite something, everything which is incomprehensible is explained!"

That bodies combine chemically in definite proportions only is undoubtedly a law of combination, but I should like to know according to what law chemical decompositions take place. Is the chemistry of decomposition anything more than a specification of the results of experiments made upon individual bodies, each individual experiment being calculated according to a fixed form? Is the word affinity anything more than a word? Nothing is explained in chemistry; everything in chemistry is incomprehensible. The vital force, on the other hand, acknowledges general laws. There is the law of periodicity, which is the direct antithesis of the law of inertia, according to which motion increases to a certain extent, and then again diminishes; there is the law of habit, according to which reaction is not always equal to action, but diminishes in proportion to the frequency of the repetition of reaction. However, I am not writing upon general physiology.

Liebig's work, mentioned above (Organic Chemistry

in its Application to Physiology and Pathology) is still an excellent one. It shows us how the proportion of the constituents of the fluids, and of the solids of the animal body, may be deduced from the proportions of the constituents of the nutritive matters. This is certainly the first step towards explaining the nutrition of the animal body and its secretions; but it is only the first step, and we are ignorant of the decomposing and the combining forces. They appear to belong to physical rather than vital forces; and even when we have ascertained these, the ultimate means by which these forces are set in action remain to be determined. And for the physician, the principal point is to increase the activity of these forces; or when it is too great, to diminish it. We must agree with Liebig, nay, we might even censure with his violence, when we see how many physiologists misapply the word life; but this blame does not attach to all physiologists, when they used the term vital force correctly, i. e. when they apply it to those cases in which chemical forces cease to act in their natural manner. It is very necessary to advance by means of physics and chemistry as far as possible, but we must not trust more to these two sciences than they are capable of effecting.

Gaudichaud has come forward with great decision against Mirbel in the Academy of Sciences at Paris. Offended by some expressions which Mirbel made use of in his 'Memoir upon the Structure of the Stem of the Date-palm,' and which Gaudichaud correctly considered as directed against him, immediately after the reading of the memoir, he briefly protested against it, and declared Mirbel's system to be incorrect. There also appeared soon after, in the year 1843, two memoirs justifying his protest. They have been spoken of in the 'Annual Report' for 1842-3, as have also his *Recherches générales sur l'Organographie*, &c. *des Plantes* in the 'Annual Report' for 1841. In the 'Comptes Rendus' for 1844, we now have the third and fourth protests against Mirbel (I, pp. 597 and 899). He has not yielded. In 1844

Mirbel read a memoir upon the Structure of the Stem of *Dracæna Australis*, of which we shall speak hereafter; and in the 'Comptes Rendus' for 1845, we find not less than seven papers against Mirbel's memoir. Many years ago even, Gaudichaud was so engrossed with his own theory, that he would scarcely listen to objections made orally to him, or which referred to investigations which he was going subsequently to publish. His style is brief, almost aphoristic, and positive, nevertheless it is not free from repetition; but he says, by way of exculpation, "I must continue to repeat until my system is generally received." From his obstinacy it may be expected that he will not yield.

Gaudichaud has also evinced this pertinacity in his life. He was an apothecary, accompanied, as pharmaceutical botanist, a voyage of discovery under the command of Freycinet, and, in September 1817, went on board the corvette *Urania*, which was shipwrecked on the 14th of February, 1820, at the Maluines. It sailed from Port Jackson southwards, next struck upon some ice-islands, then rounded Cape Horn, and cast anchor in the Bay of Good Success, at Terra del Fuego. A violent gale of wind compelled them to cut their cable and stand out to sea. Some days afterwards, during the most beautiful weather, the ship was driven upon some concealed rocks near the Maluines, and twelve hours afterwards upon the sand in the bay or creek called by the French the Bay of Solitude, where it still remains. It was four o'clock in the afternoon when it went upon the rocks, and four o'clock in the morning when it was wrecked on the sand-bank and sunk. The interval between these two events was a dreadful night of anxiety and danger. Gaudichaud was fortunately saved, but the whole of his collections were submerged, and could not be removed until they had been from thirty-six to forty hours under water. He was obliged to wash every packet, in fact every sheet, in fresh water, and to dry them; and thus during the four months which he passed there, he was enabled to save

about 4000 specimens of plants out of 6000. He returned to France in December 1820, with the corvette *La Physicienne,* which the government had purchased at the Maluines. He wrote there the botanical part of the description of the voyage, and also planned his 'Organography and Physiology of Plants.' In 1831 he went in the frigate *Herminie,* under command of Villeneuve Bargemont, to the coast of South America. The frigate sailed twice round Cape Horn, and returned in 1832 from Rio de Janeiro to France. Gaudichaud, however, obtained permission to remain in the Brazils, from which country he returned to Toulon in the corvette *La Bonite,* Captain Durand, in June 1843. In April 1835, he delivered his remarks on the 'Organography, Organogeny, and Physiology of Plants' to the Institute; and in December of that year, on the day on which the Monthyon-prize was awarded to him, he left Paris to make his third voyage in the corvette *La Bonite.* He started from Toulon in February 1836, and returned in the same ship at the end of the year 1837. I have derived this information from the account of his life in the 'Revue générale Biographique,' which adds further: "Gaudichaud, that energetic man, born with the Revolution in 1789, and grown up in it, has fought several duels, but," it adds, "all who were acquainted with M. Gaudichaud know that he never took the lead in these affairs." I have not given these details of Gaudichaud's life here entirely without an object.

"What," says he (Compt. rend., 1844, 1,598) "is a Monocotyledonous plant at its very origin, e. g. a Date-palm? an animated cell, which produces an embryo or a bud. An embryo, as all botanists now know, is a free, isolated, independent cell. This embryo, or this primitive phyton, is a distinct individual, possessing its own peculiar organization, and its peculiar functions. The first individual soon produces a second; the second, a third; the third, a fourth, and so on, during the whole life of the plant. As the embryo possesses its organiza-

tion and its peculiar normal functions, so will also the individuals produced by it, and by all those which follow it, and which possess their own separately, i. e. modified according to the stages of their development and their age, the second being directly and constantly grafted upon the first; the third upon the second, and so on, each one being grafted upon the other. The first individual, the embryo, derives the principles of its existence from without, from water, air, light and heat, but especially from the albuminous body (perisperm), when it is present, which nourishes the embryo, and is thus absorbed; the second is nourished by the first; the third by the second and the first, and the fourth by the three others, as well as by the elements previously named; hence it follows, that when the phytons are perfectly developed, the first remains very weak; the second is somewhat stronger; the third is still stronger; and that all the subsequent ones become stronger and stronger, as also more complicated in form, and consequently in functions, until we arrive at the normal leaf, which has attained the highest stage of organization."

Gaudichaud says, all botanists now know that the embryo is a bud, whence it may be readily deduced, that the bud is just the same as the embryo, and must have roots like it. But this is not the case, the embryo is not a bud, nor the bud an embryo. There is an old and every-day observation, which I am accustomed briefly to explain in the following manner: the embryo—produced by impregnation—propagates the species; the bud, the individual. A branch with buds, from a Borsdorf apple-tree, when grafted always produces Borsdorf apples, whilst the seed of a Borsdorf apple never does so. Differing in this important property, it may also differ in other respects, hence it does not follow that the bud should have roots like the embryo. Moreover, the leaf is not an individual, it is only such when united with the buds, and these at first contain only cellular tissue, extremely few spiral vessels. Such buds, when united together, form Mirbel's *Phyllophore*.

We shall allow Gaudichaud to continue.

"According to the old theories, the vascular system of the second individual is formed by a division of the vessels of the first. Hence the vascular system of the second individual is composed of a portion of that of the first. But if the vascular organization of the second individual is more compound than that of the first, the vascular system of the second cannot be formed from the vascular system of the first. If it be granted that all the vessels of the embryo pass into the primordial leaf, the latter should always possess the organization of the embryo only. But this theory is, I think, now properly rejected. According to the theory propounded to you on the 12th of July (by Mirbel), the vessels of the primordial leaf must emanate from the inner periphery of the embryo. We are here met by the same difficulties. In fact, what becomes of this theory, when it is proved to you by a large number of facts that, as a rule, the primordial leaf is more highly organized than the embryonal leaf, and that e. g. the fourth and fifth leaf almost always contain more vessels than the three or four first leaves; moreover, when we show by the same facts, not only that the cotyledonary leaf does not send vessels to the primordial leaf, but also, that in many cases it does not receive any from above, and it then has only an ephemeral existence. In this case the first leaf ceases to exist, because it is not strengthened, and to a certain extent vitalised by the second leaf. Is not this an evident proof of the individual vitality of the phyton?"

Mirbel maintains, if I am correct, that all the vessels of a Palm-stem are not only derived from the internal periphery of the embryo, but also, that wherever leaves arise, new vessels are developed, and thus that they appear at the rings, internally, at the periphery of the stems. From observations which I have made upon this point, I believe that Mirbel is incorrect; I do not find bundles of woody or vascular tissue arising from the rings within the stem, but they all appear to arise from the base of

the stem, and then traverse it in its entire length. Near the periphery the vascular bundles are so crowded that it is difficult to separate them and ascertain their course.

Gaudichaud continues: "We shall naturally apply this principle to the growth of the stem, leaves, fruit, &c., and also extend it to the flowers and other deciduous parts of plants. We would also apply it to the stem of *Vellosia*, which, as it derives scarcely anything from the leaves which exist at the ends of the branches, always remains very thin, for the simple reason that the vessels of the roots of the leaves which should produce the increased thickness of the stem, become applied immediately after their formation to the external part of the bark (*à l'extérieur du périxyle*), and thus descend as roots (*à l'état de racines*), along the twigs, the branches, and leaves, to the ground. The primordial leaf (that first formed after the embryo), undoubtedly obtains life and nutriment, but nothing further, from the embryo; the primordial leaf also imparts vitality and its principal nutriment to the second leaf, and the same occurs with the second leaf in regard to the third, &c."

Gaudichaud always writes in this aphoristic style, which becomes more remarkable from his separating the sentences from each other, and commencing a new line.

Again, he says (l. c. p. 610): "In fact, since it is found by observation, that the embryo, this small isolated being, consists originally of cellular tissue only, and that this cellular tissue produces the vessels by its physiological action; that the vessels commence in the internodes of the stem (*mérithale tigillaire*), then appear in the petiolary and the laminary meriths of the leaf; that they are perfectly formed, or at least may be traced in these regions (*dans les parties mérithalliennes*), before they appear in the *papilla* of the rootlet (*mammelon radiculaire*), we are led by analogy to consider that the same must also be the case with the organization of other individuals, of whatever kind they may be, which are produced by plants. This fact I repeat is an important one, and worthy of conside-

ration. I have several times recurred to it, and shall again recur to it, because I believe that it is the key to vegetable organography; because it comprises a theory of the regions (or members) (mérithalles), which I defend; and because it supersedes (*infirme*) all other theories." The basis of his system is principally contained in these words.

Gaudichaud's whole theory rests upon the perfect identity of the buds and the embryo, and the formation of roots or root-like parts in the former as in the latter, when the branch grows. This explains the increase in thickness, which is always a difficulty, especially in the Monocotyledons, and in the cauloma of Palms. It has already been stated above, that the resemblance of the embryo and the buds is not so great as Gaudichaud thinks. Roots growing downwards in the stem are attributed to buds from analogy only, and this is imperfect. Although Mirbel explains the increase of the stem of Palms by the origin of new vessels from the interior of the circumference of the stem, yet the accurate explanation of the entire process is accompanied with great difficulties, independently of the fact that this origin of the vessels cannot be found on accurate examination. But the difficulties vanish if we admit the occurrence of lateral growth, which appears probable at first sight. In my Lectures on Botany (Part II, Berlin, 1845, p. 309), I have shown that the stem of the Date-palm in its early stage, much resembles a bulb, which also at first increases in thickness, and then ascends in the form of a stem; I have, moreover there (p. 237) detailed observations, which show that in the stem of the Dicotyledons, a layer, sometimes thick, sometimes thin, applies itself; this, however, especially indicating lateral growth. Thus the roots of the buds do not pass far down the stem. It is extremely probable that a little cellular tissue may grow downwards from the buds into the stem, but it is doubtful whether vessels descend from the buds into the stem, they certainly do not pass down far in this manner (see my Lectures, &c.,

p. 265.) Mirbel and Gaudichaud pay altogether too little attention to the relative growth and position of the vessels as regards each other. The pertinacious man, as evidenced in his life, will hardly sacrifice any of his theory to controversy; but if it should ultimately tire even the impartial critic, this ought never to go so far as to cause the theory to be rejected without examination.

Schleiden is the most violent of the botanists mentioned at the commencement. As soon as he meets with an opposite opinion, he rejects it immediately, and so positively, as not to admit the correctness of a single assertion in it. The author of such opinions fares still worse; everything of his ceases to be good. By this means, with few exceptions, he has excited all botanical writers against him, and caused many of his own theories to be rejected by others. This should not prevent the acknowledgment of what is good and excellent in him. When we see the straightforward and positive Gaudichaud, we expect a pertinacious adherence to his opinions, but from Liebig's amiable aspect we should not anticipate so severe a man, nor should we suspect, of the quiet Schleiden, that he could trample upon all who differ from him. The first edition of Schleiden's 'Principles of Scientific Botany' was not incorrectly called a libel, in France; this reproach would be unjustly made to the second, on the whole, although in parts the same violence is manifest, and probably expresses his feeling. After its dedication to Humboldt, which all who know Humboldt must admire, the following passage immediately follows, in the preface: "It is an infinitely difficult task, again, to throw off the accessory means of education and to retain education alone, to apply the stifled power independently to objects which have been spontaneously selected. On the large scale this is most strikingly seen in the laughable prejudice for Latino-philological erudition, and the mediæval monkish book-wisdom, which makes all true living progress in our education appear distorted and crippled as an inherited dyscrasy, and just where it appears in its

greatest absurdity, in the Natural sciences, still disturbs the fresh springs of life." Had this been said one hundred years or more ago, it might have been regarded as an expression made at an appropriate time, but it now comes much too late. We must now rather thank those men who, like Humboldt, appreciate the advantage of still cultivating the taste for the dead languages and philological erudition. Humboldt has done this in very many of his writings, very recently in his 'Cosmos,' in a manner which, as we may hope, and must wish, will exert its influence upon an age which is too fond of what is superficial and easy, beyond which it has no desire to proceed. I shall allude here to the effect upon the mind which the wonderful force and simplicity of the dead languages exert, when we regard the impression which they produce only, without referring to the dilution which they always suffer by translation into modern languages. This is foreign to my present purpose. But in the Natural sciences their use is really not absurd, it is much to be recommended in descriptive Natural History, and hitherto has always been retained.

In these languages all European nations understand each other; the plants and animals described by us, Germans, are again recognised from Lisbon to Moscow. Schleiden speaks of the absurdity of species-trifling; but here again, in his peculiar style, he says too much, because the first point is to ascertain what is spoken of, and the determination of species must serve as the alphabet of science; and it then leads us to the answer to one of the most important questions in Botany, viz. what is a species, what a variety, and how the latter are produced? It is, perhaps, most proper that papers which dispense with this, as it were, mechanical method of illustrating objects, should be wholly written in the mother tongue; but it would be well if so much Latin were learned as to cause those manuals which make use of an aphoristic style of description, especially in the Natural sciences, to be understood in every foreign country. The English,

French, and Italians, even at present, are but little acquainted with our labours in the Natural sciences. We, with whom it is part of the education of youth to learn the languages of these nations, more readily become acquainted with the labours of other nations than they do with ours, because our language is much too difficult to be learned by these nations. Hitherto the Russians, in their writings on these sciences, have generally made use of Latin, French, and German; but if they were to begin to write in their own languages, and simultaneously to make great progress in the sciences, we must then either remain in ignorance of their works or learn their language. But Schleiden condemns learning from books, and in his opinion it is of no consequence whether we are acquainted with what has been observed by foreigners or not. He says, in the same preface, "True formative knowledge, that which expands the nobler powers of the human mind, can at the most be acquired in and with the assistance of books, but never from books. Learning from books is the secret and unsuspected source from which the disingenuousness and tendency to dissimulation is first nourished, and which poisons the present age: accustoms us from youth upwards neither to say, to think, or to do anything of ourselves, but merely to fill our meagre and sterile minds with ideas which have been borrowed and handed down from other sources, so as to palm off this abundance as healthy knowledge." He frequently repeats that he has striven to be peculiar and original. In the same preface he says, "I had endeavoured at once, and without any regard to what had already been done, but furnished with all the expedients at our command in the present day, to rediscover the whole science from the direct investigation of nature; thus my work acquired an originality, which, independently of its correctness, always possesses something more attractive than the matter when arranged in an historical and philological form." The author somewhat deceives himself. Where there is a noise, there flock boys and

idlers. He is far less original in his views than Thouars, Turpin, Agardh, Nees von Essenbeck, or Oken, and in description, Gaudichaud is far more vigorous and distinct. As regards his accuracy, this cannot be so easily and readily decided upon, as to exert any striking influence upon the judgment of the reader. Thus, e. g. in the first edition of his book, he follows the theory of the French botanists on the stem, which he certainly defines with more minuteness; and in the treating of the stem of the Palm, he criticises what I have said upon the subject, but without supporting his remarks by any original observations. Original writers are certainly not those who have produced most benefit to science, whilst on the other hand they have frequently retarded its progress, and I should not consider it as any recommendation, were any one to assert that Schleiden was original in his botanical remarks. On the whole, he recommends the critical method, in fact, considers it as the only correct one; but we cannot possibly conceive criticism without some preceding system; in fact, it is quite opposed to peculiarity and originality. It is highly valuable, and we should be grateful to the author's ingenuity if he allowed his criticisms to be decided and severe, but free from such extravagancies, which impair rather than increase the effect they produce. The observations of any writer upon natural history, who only describes what he has seen, are very valuable; but it would be impossible to re-institute a science from the study of nature alone. In making investigations we must know what to observe, and this must be acquired from instruction, and finally from books. Without these means we should merely make discoveries which had long been known. Had it not been learned from books, we should not have been aware that iodine colours starch blue. I was deprived of this resource in my earlier researches, and it has since proved of much service in science. It is too great an exaggeration, nay, it is even false, to assert that books cherish a disingenuousness and tendency to dissimulation which

poison our whole existence. We might with more truth accuse social life altogether, which no doubt frequently renders dissimulation necessary to prevent one being thrown upon the street (obliged to beg).

The author, whilst combating dogmatism in his 'Methodological Elements' (p. 23), passes the following incorrect judgment upon Endlicher and Unger's 'Principles of Botany' (Vienna, 1843). "This false plan is carried out to its utmost extent in the recent work of Endlicher and Unger, and its appearance under the protection of such names can only be seriously regretted. It appears to me that independently of many of the details being objectionable, to which we shall allude hereafter, the authors in writing their book in a rigidly scholastic style, at the present day, have committed a great mistake. From beginning to end, it contains mere explanations of names arranged systematically, and what renders them especially useless, is that the authors have rarely taken the trouble to name examples. Anatomy, physiology, and the history of development, which alone should constitute the peculiar value and true foundation of the details, are very meagre and unimportant, the figures, which are appended at the end, are neither formally nor essentially brought into connexion with the details which are deducible from them only." All knowledge in the natural sciences depends upon definitions, for every fact is comprehended as a definite conception. Merely because the perception of an object or occurrence is repeated, does it become absorbed as manifold, in the unity of the idea, and in this form, we become acquainted with it. In all sciences, and especially in natural history, we must commence with definitions. We must first obtain a definite idea of a part of an organic body; the external form and the connexion with other parts are the first and the most important points to be regarded, for by them we recognise the part; the internal structure, the anatomy, certainly must be known, but it is entirely a subordinate matter. Then follows the doctrine of development, for I must first know

what is developed, and from what this is derived; and the physiological examination of the species follows last. Now I confess that I am unacquainted with any manual of botany which, with aphoristic brevity, fulfils its design so admirably, as the 'Principles of Botany' of Endlicher and Unger. My disagreement with the authors in a few, in fact, in many of their theories, is nothing to the point, for, in so extensive a field, it is impossible always to meet with accuracy. Schleiden finds fault, e. g. with the distinction which the authors make between a conical and a discoid receptacle, when speaking of the floral receptacle, and puts a variety of questions, which in my opinion may be easily answered. The discoid receptacle is furnished beneath the ovary with an annular ridge, which is absent in the conical receptacle, and if I understand the authors correctly, they regard this as an indication of another internode of the stem which commences there. Thus they have explained the presence of the various parts situated beneath the ovary, for by explanation we signify the illustration of the essential connexion of phenomena. But I doubt whether an appendage does not always exist beneath the ovary, indicating the origin of another internode.

Schleiden's theory of the internodes of the stem, mérithalles, as they are called by the French in their usual manner, by a barbarous term derived from the Greek and in opposition to all analogy, is old. The place where a leaf and a bud exist, was called a node, and this was regarded as the commencement of an internode. In the Grasses, each node is evidently the commencement of an internode; in the Palms, internodes are closely crowded and somewhat less easily recognised; the nodes and the internodes are also distinguishable in the Labiatæ, the Caryophyllaceæ, &c., which have opposite leaves, whilst in plants with alternate leaves, they run into each other. If we consider the term node to denote the articulation, we might say with Endlicher and Unger, that in the conical receptacle, there is no node situated above the stamens, until we come to the ovary, whilst in the discoid receptacle, one does exist.

"The peculiarity of the inductive and modern method," says Schleiden (p. 25), "consists in our first completely abstracting ourselves from all hypothesis, not premising any principle, but starting immediately from our direct consciousness, from individual facts, endeavouring purely and completely to isolate these, arranging them according to their essential affinity, ascertaining from them alone laws to which they are subject, and which are essential to their existence, and thus tracing them back, until we arrive at those ultimate ideas and laws, with which all further deduction ceases to be possible." This may be very true; but it is least applicable when the doctrine of development, anatomy, and physiology are assumed as the foundation of the investigation. The second book, the doctrine of cells in plants, begins as follows (p. 197): "Cells can only be formed in a liquid which contains sugar, dextrine, and mucilage (cytoblastema). It takes place in two ways:—1st. The mucilaginous parts become condensed into a more or less roundish body, the cell-nucleus (cytoblast) and at their whole surface convert part of the liquid into gelatine, or comparatively insoluble substance; a closed gelatinous vesicle is formed, the external liquid penetrates into and distends this, so that the mucilaginous body becomes unattached on one side, and remains adherent to the other side of the internal walls; it then forms a new layer on its free side, and is thus inclosed in a duplicature of the wall, or it remains free, and is then usually dissolved and disappears. During the gradual distension of the vesicle, the gelatine of the wall usually becomes converted into cellular matter, and the formation of the cell (cellula) is completed. 2d. The entire contents of the cell become divided into two or more parts, and from each a delicate gelatinous membrane is immediately formed; in this manner several cells are simultaneously developed, which then completely fill the cell in which they were formed."

Upon how much that is uncertain is this based! In his explanation, the author himself directly says, "We are far from clear as to the liquid from which the cells

are formed." This is so certain, that the author commences with "It appears." It is moreover uncertain, and is doubted by many, myself among the number, whether a cytoblast is formed before the surrounding membrane; we have never seen it. Although we may find granules, and subsequently cells, in a clear liquid, it does not follow that the former are formed from the latter, moreover, the young cells under these circumstances are frequently empty; sometimes certainly they contain several nuclei. Moreover, it is hypothetical and cannot be seen, that the nucleus of the cell converts part of the liquid into gelatine; that the external liquid permeates the gelatinous vesicle and distends it, is also hypothetical; and, lastly, it is no less hypothetical that the gelatine of the wall becomes converted into cellular matter, and that in this manner the cells are perfected. It is by no means my intention to assert, that these facts are false; I merely wish to say, that we must not commence with these statements—with what is doubtful and uncertain.

I have several times reminded the reader that the cells of the Algæ cannot be regarded as analogues by which the development of cells in the Phanerogamia can be explained. The cells of the Algæ are rather to be compared to the joints of the stem in the Phanerogamia, than with the individual cells of which the stem is composed. The cells of the Algæ are placed in a long tube, and hence were called utriculi, and, in fact, utriculi matricales by Roth. Moreover, the remarkable phenomena which are perceptible in several of the cells of the Algæ, as, e. g. in *Spirogyra*, *Stellulina*, &c., appear to characterise them as peculiar organs. The author remarks, in passing (p. 205): "To guard against false views I must observe here, that the theory of crystallization brought forward by Link, according to which crystals are formed by the confluence of small globules, depends upon imperfect observation." I never thought of saying anything of the kind. When a recent precipitate, as e. g. of carbonate of lime, is quickly placed under the microscope, we observe

nothing but globules, and what proves them to be in a fluid state, is that they are frequently seen to run into one another. The crystal is then suddenly formed; in the above instance, it is a rhombohedron or crystal of Arragonite, according to the temperature. Schleiden has not seen this, and is unacquainted with my little work, 'On the Formation of Solid Bodies,' Berlin, 1841. My friends H. and G. Rose and Poggendorf have seen it. But further: "At first it is natural, that if we desire to observe the formation of crystals, precipitation should not be selected for the purpose, which chemists consider to belong to the so-called irregular form of crystallization, but that the observations should be made at first upon simple crystals whilst separating from concentrated liquids. In this way we observe in each case, as e. g. with nitres, ammonio-chloride of platinum, and most beautifully and readily with the ammonio-chloride of zinc, &c., that the nuclear crystal suddenly springs up, not at any given moment, in the liquid which was previously perfectly clear, and which remains so, and then whilst apparently at perfect rest, is seen gradually to increase in almost imperceptible starts by external deposition." If some chemists consider precipitation as only irregular crystallization, they have done wrong. The above means of making the observations are totally impracticable. If the concentrated solution be allowed to evaporate slowly, the formation of the crystals can only be observed with great difficulty; if it be allowed to cool suddenly, the crystals are formed so suddenly and in such numbers, that individual crystals are difficult to trace. Precipitates which crystallize slowly are the best to examine, as e. g. carbonate of lime, very little of which must be placed under the microscope. In precipitates which crystallize rapidly, as sulphate of lime, the first stage of globules cannot always be perceived, as the crystallization ensues too rapidly; sometimes, however, for this very reason, the phenomenon is seen with surprising distinctness." Further: "If, however, two liquids which yield a single precipitate be mixed

under the microscope, at the instant of their coming into contact, the sudden formation of a membrane, which separates the two liquids, is seen to occur. On minute examination, this membrane is seen to consist of crystals, some of which can be perceived with perfect distinctness, some are seen to be crystals when magnified more strongly, others only when the very highest magnifying powers are used, until lastly the smallest appear only as points, even with the very highest powers. If the liquids are not disturbed, some of the crystals which are formed gradually enlarge on both sides in the liquid; but if the liquids be mixed, a large number of the crystals are instantly redissolved, others continue to increase in size, and fresh crystalline nuclei are suddenly formed in spots where the liquid was perfectly clear." These observations are upon the whole correct; the so-called membrane is a wall of turbid liquid. As long as it appears like a membrane, it is not composed of crystals, but these are soon formed, and it is then composed of them. A similar turbid wall is also seen when the freezing of water is observed with the microscope. See Poggendorff's Annal., vol. 64 (1845), p. 479. Lastly, "After having made many observations and these with great care, I have arrived at the general conclusion, that every inorganic substance, when passing undisturbed into the solid state, immediately assumes a crystalline form; most of the so-called pulverulent precipitates consist of crystals, and the comparatively minute size of others prevents our giving any opinion upon their form." This is certainly the common opinion. But Ehrenberg was the first to show that many fossils consist of globules arranged in rows, and therefore are not composed of crystals, and if the drop of liquid containing the precipitate of carbonate of lime, under the microscope, dries up too quickly, a quantity of powder remains between the rhombohedra, and this entirely consists of small globules. The pulverulent condition of matter therefore, which, I believe, Weiss is almost the only one to admit as a distinct state, cannot be rejected. That crystals are

not at once formed in the liquid, but that a nucleus is first suddenly formed from a liquid, which subsequently increases in size, my observations upon precipitates have shown distinctly.

The author's remarks (p. 53 et seq.) upon the production of the various forms occurring in nature are upon the whole correct and to the purpose. The form either excludes the mother-liquid, i. e. the formative fluid, during its production, or it incloses it. The first is the case in inorganic, and the latter in organic bodies. I should not say, that the crystal during its formation excludes the formative fluid, for the entire globule, or the entire aggregation of globules, in the above experiments is transformed into the crystal. Moreover, this consideration appears to contradict the author's own opinion upon crystallization, according to which the crystal is at once formed in the liquid, and during its increase merely withdraws particles from the formative liquid. But it is certainly of great importance that organic bodies should be formed within an envelope, where external agencies are directed towards the centre of the formative liquid. When the author says: "We thus characterise the idea, organism, as the relation of the figure or form to the inclosed mother-liquid, and life as the reciprocal action exerted between the mother-liquid and the form," he must, on a little reflection, understand how very unsatisfactory are these characteristics. It was, therefore, with satisfaction that I read the author's remarks (p. 64 et seq.) upon Minerals, Plants, and Animals. They contain—if he will not take it unkindly—a poetical effusion, which if it does not distort the facts, forms an agreeable embellishment to the subject.

The treatise on the Microscope (p. 82 et seq.) may be strongly recommended to those who make use of this instrument, although I find the following passage at the end of it (p. 105): "It is considered that little more is required to make a microscopic observation than a good

instrument and an object; the eye has then only to be kept above the eyepiece for the observer to be *au fait*. Link, in the preface to his Anatomical Plates, expresses this thoroughly false view as follows: 'I have generally intrusted the observations entirely to my draughtsman, M. Schmidt, and thus the unprejudiced condition of the observer, who is unacquainted with botanical theories, vouches for the accuracy of the drawings.' The result of this perversion is, that Link's phytotomical plates, notwithstanding his celebrated name, are so useless, that the beginner, at least, must be strongly warned in learning from them, to avoid his being confused by representations which are entirely false. Link might as well have asked a child, or a congenitally-blind person who had just been operated upon, the apparent distance of the moon, and from their freedom from prejudice, have expected the best judgment, just as if in our early years of childhood we commence learning to see with our unaided eyes," &c. I must subjoin here the preface to my Anatomico-botanical Plates (Pt. i, 1837): "The anatomy of the human body only first began to make the great advances in which it now rejoices, when philosophers began to have the appearances delineated by skilful artists. I followed this course as far as I was able. For philosophers are seldom good draughtsmen, and even when they do understand the art, they have no time for its exercise. Hence it very frequently happens that they draw what they have never seen, or what they fancy they have seen under the misguidance of some theory. This is especially the case when the objects can only be seen under the microscope. The most proper person for this purpose is a skilful artist who is unacquainted with anatomical science, and who must not be told what he is to see. A young artist, C. H. Schmidt, who is a flower-painter, has for seven years drawn for me the internal structures of plants, as seen under the microscope. After he had become accustomed to the microscope, I told him that he must only draw what he saw, and always unhesitatingly contradict

me, if he thought differently from me. He did not interest himself in theories, not even in mine. I have presented some figures selected from a large number, which appear to me very accurately and carefully drawn, and shall continue to do so if the undertaking should receive support." I therefore by no means leave the observation to the draughtsman, but only the delineation; I correct him, but do not at once desire compliance, as with a young and dim-sighted artist, but contradiction. I confess that I had in my mind the Plates upon the Circulating System of Plants, and especially Meyen's illustration of the network of the so-called vital vessels in the leaves of *Alisma plantago*. The brief preface to the second half of the Anatomico-botanical Plates concludes with the following words: "But we learn to see, both with the eyes given to us by nature, and with those formed by art." From that time to the present (January 1846), M. Schmidt works with me five days every week in the morning, except during my autumnal tour, and does not draw anything which I have not carefully observed, and my eyes, thank God! are as good as ever. I educated my draughtsman for microscopic delineation, and at the end of seven years he was so far advanced, that I could reason with him; now after sixteen years he is still more so. How can any one be thought so foolish as to have drawings made under his own superintendence without pointing out their object. I beg M. Schleiden not to consider every one a fool but himself.

I must, however, apologize to the reader for having become prolix on matters relating to myself. But something more upon a purely scientific subject. "That property of the cell has already been mentioned," says the author, in the chapter upon "The Life of the Cell," p. 273, "in virtue of which it transmits fluids. It is a perfectly superfluous and clumsy hypothesis, in the explanation of this point, to have recourse to the existence of minute invisible pores; the membrane and liquid here stand in the same relation to each other, as

salt and the water by which it is dissolved. Just as in this case both salt and water are contained in every differential of magnitude (sit venia verbo), so is the cellular matter and the water in that of the membrane; with this difference, that the membrane is never rendered fluid by the water, because the latter merely dissolves a definite minute quantity, and then does not take up more water until the portion first taken up has been removed." Now, where do the aqueous particles exist in the membrane? They cannot exist anywhere but in its interstices, however minute these may be, and however minute the particles of the membrane may be, between which the aqueous particles penetrate. Undoubtedly such interstices, which we call invisible pores, must exist, unless we admit an infinite penetration of the water and the membrane. Independently of the fact that such penetration cannot be perceived, nor even imagined, the water and membrane would then form an indivisible substance. The penetration would also be mere groundless hypothesis. Salt, when in solution, certainly exists only in the interstices of the water; soluble bodies force carbonic acid from the pores of water, because they take its place themselves. Our system of physics must be altogether modified, if we are to deny the existence of invisible pores. Physio-philosophy is alone capable of affording an explanation of this, because, according to its theorems, all forms of matter are originally the same, and the differences depend upon an increase or a diminution of the cohesive attraction of one for the other. Still it would be difficult to find in it an explanation, where membrane and water only are concerned, without admitting the existence of such pores. Are we, then, who are accustomed to work with the microscope, to pretend that we can see everything? Thus there are different gases, none of which are visible to us, and in which we must admit the existence of large interspaces, for the explanation of the phenomena which are exhibited when they are mixed with each other or with aqueous vapour. That these pores are not disseminated

empty spaces, is readily understood; but they are, in most cases, filled with some subtile matters, as air, heat, &c. The membrane of organic bodies allows fluids to permeate it; in endosmosis this is probably effected by electricity. In the living body, these pores appear to open and close—an effect of the vital force, which in many other cases manifests itself to us by contraction and expansion.

Schleiden completely follows Fries in his philosophical views, and has written a pamphlet against Hegel and Schelling, in which he states that he does not attack their system, but merely endeavours to show their ignorance of natural science. The followers of these two philosophers might find much to censure in it, as, in my opinion, would the followers of Fries also, in his illustration and application of the philosophy of Fries. I consider myself as rather belonging to the latter; but this is not the place to discuss the matter. The author does not mention Oken, who certainly deserves consideration. However, I will not give rise to a dispute, which under the present circumstances could not prove of any advantage to science.

Scientific disputes are usually beneficial to the progress of science. They not only augment the interest of science itself by producing novelty in its monotonous course, but they also possess the advantage of causing the disputant to develope the grounds upon which his opinion is based, more fully, for the sake of more clearly illustrating it and convincing his opponent. Whether he succeed in the latter or not, must be left undecided by the disputant; but so much is certain, that if this is not immediately or very shortly the case, one or the other ultimately acquires conviction. The advantage which would result from the development of the grounds for or against any view vanishes, when mere contradiction—i. e. rejection without a reason—is made use of. It produces the least advantage to science when the dispute is carried on with a truly original rudeness, as is generally done by Schleiden.

It is very wrong to repudiate physio-philosophy as paying no regard to facts, but proceeding with purely mental conceptions. Such is not the case. Oken, Nees v. Esenbeck, and Wilbrand, like all other physio-philosophers, assume facts as their basis; and only err, in my opinion, in comprising them under ideas of too wide an extent. Thus, under the idea of polarity, they include so many heterogeneous phenomena, that the definition and application of the idea becomes too arbitrary. In general, polarity signifies an antithesis in different directions. This occurs very frequently in nature, but so generally, that recourse to it not only becomes tiresome, but even superfluous, and withdraws us from more important and exact investigations. More accurate and strict definition of the ideas is requisite, and this again necessitates more minute and rigid determination of the facts. The opponents of physio-philosophy have erred in this respect also. Thus the idea of a cell, as now generally understood, cannot be mistaken; but when we find how the embryo-sac, the cells of the pith and bark, spiral vessels and the joints of the Algæ are so comprised in this term, that what applies to one is considered as holding good as regards the others, there is risk of falling into the most serious errors. The greatest injury effected by physio-philosophy, has arisen from its not only rejecting mechanical philosophy, but even holding it in contempt. Hence the fundamental theories of physics, the theories of motion, have been so neglected in courses of instruction, that we have had to censure the want of acquaintance with them above, even in the opponents of physio-philosophy themselves.

INTERNAL STRUCTURE OF PLANTS.

In no department of physiological botany, if we except the formation of the embryo, has so much been done during the last few years, as on the formation and deve-

lopment of cells. The investigations exhibit a depth of research, which commences with the very earliest origin of the plant, and in this respect they are very valuable. First, Mohl, to whom we are indebted for most of our knowledge on this point, has published:

Remarks on the Structure of the Vegetable Cell, in the *Botanische Zeitung*. Edited by H. von Mohl and L. von Schlechtendal. Berlin, 1844, p. 15 et seq., and p. 273 et seq.—He was led to these researches by Hartig's investigations upon the structure of cells, and his assumption of their possessing a more internal membrane which lines their interior, and which he denominated a Ptychode. "If we examine a first year's shoot of a tree, or the stem of an annual plant, which, before the completion of its growth, has been immersed in spirit and kept in it for some time, we find in all those cells and vessels, the secondary layers of which have not yet attained their full development, an inner membrane, which is remarkably distinct from the other membranes of the cell. This membrane forms a perfectly closed, cell-like, thin-walled vesicle, which in the fresh plant is closely applied to the inner wall of the cell, and therefore escapes observation; whilst in specimens which have been preserved in spirit, it is contracted, and more or less detached from the wall of the cell." He calls this cell-like vesicle the primordial utricle, and found it in a number of Dicotyledonous plants, as, e. g, in *Sambucus ebulus*, *Ficus carica*, *Pinus sylvestris*, *Asclepias Syriaca*, *Hoya carnosa*, *Euphorbia Canariensis*, *Caput Medusæ*, &c. In the Monocotyledons, he detected it in the apex of the stem and of the root. But this utricle can be seen by a shorter method than that of keeping the portions of the plants for a long time in spirit. In general, the preparation need only be exposed to the action of nitric or hydrochloric acid for a few minutes; if the acid be then neutralized with ammonia, and the preparation be coloured by iodine, the primordial utricle is

seen just as beautifully as by the long preservation in spirit. As the primordial utricle exists in all young cells, the author thinks that it contributes to the formation and growth of the cells; for, he adds, we can only conceive cell-growth to occur in two ways, either by division of the older cells by the formation of a septum, or the formation of cells within other cells. He believes that in the cambium-layer of *Pinus sylvestris, Sambucus ebulus, Asclepias Syriaca,* and *Euphorbia Caput Medusæ,* he has seen two primordial utricles prior to the appearance of a septum between them, which, therefore, confirms the latter method of formation. However, he is by no means free from doubt on this point. What we have just asserted entirely agrees with Schleiden's theory, except that Schleiden believes the cell-membrane to be formed from the nucleus. Mohl, on the other hand, considers that the cell-membrane always surrounds the nucleus. Moreover, according to Schleiden, the cell-membrane first formed constitutes also the later one—the external membrane of the cell; whilst, according to Mohl, the membrane of the primordial utricle becomes the external membrane. Hermann Karsten mentions having seen the primordial utricle in his memoir, 'De celle Vitali;' but he confounded it with the internal layers of the membrane of the cell. The author names several excellent examples of the various cell-membranes, and concludes, in opposition to Hartig's opinion, as follows:—"The above remarks show that a positive decision of the question, whether the cells are invested with a special membrane or not, is accompanied with no little difficulty, since optical illusion (Mohl means a luminous appearance) and a slight modification in the substance of the innermost layer of the cell, and this may also occur in the intermediate layers, may readily lead to the belief that such a membrane has been found. Hartig obtained his proof from the cells of *Taxus baccata,* in which Mohl long since showed that there existed a third layer. We must

gratefully acknowledge that Mohl has now first taught us the true structure of the membrane of the cell; that the wall of the cells and vessels is composed of a primary, external, imperforate membrane, and a secondary one which is usually perforated with apertures. It constitutes the basis of our knowledge upon this subject. We may add, with Payen, the outer membrane is not coloured yellow by iodine, whilst the internal lining is so. Mohl further adds, that the internal membrane consists of superimposed layers. This is by no means rare, especially in the solid, cartilaginous, so-called stony cells, several remarkable examples of which have been adduced by the author also in this memoir; but is not found in all, at least has not been positively detected. Why, then, should we admit their existence in parts where they are not visible? How the primordial utricle is converted into a cell having a separate existence, the author does not by any means show; and we shall hereafter allude to the fact, that it not only exists in the young cells, but also in those which have completed their growth, and not unfrequently even in old cells, provided they have not become too solid and cartilaginous. But when Mohl says, that the increase of cells takes place either by the division of the older cells, by means of a newly-formed septum, or by the formation of cells within other cells, a third plan is evidently overlooked—viz. the formation of new cells between the old ones. Mirbel has already shown this in his memoir upon *Marchantia*. It appears to me to be the true manner in which their increase takes place. I have had the anatomy of the bulb of *Amaryllis formosissima* drawn in my Plates (Part I, pl. 1). We there see, in fig. 4, at the base of the leaves, a zone of short, laterally distended cells, with thinner walls than those above and below them. Hence they appear to have been recently formed; moreover, the granules contained within them are not coloured blue by iodine, as the granules in the cells, which are situated

above and below them. The latter cells are large and polygonal, tolerably uniform in diameter, and contain large granules of starch. If we imagine to ourselves these transverse cells extended longitudinally, they would assume the same form as the polygonal cells existing above them. These transverse cells appear to me to be those last formed, and to have sprung up where the large polygonal cells are separated from each other, and have left gaps. That such gaps must be formed during the growth of the parts is unavoidable. As the stem increases in thickness, the woody bundles of the liber become separated from the pith, and the layers of woody tissue grow up between them. These certainly could not force asunder the parts between which they grow, but these latter must separate from each other, by virtue of a distinct and peculiar vital power of expansion, to allow the growth to take place. Physiologists, in giving their attention to matters of little consequence, often overlook others which are of great importance, as has happened in the case of this peculiar property. Mohl has nowhere shown, as he very modestly confesses, that the increase of the cells is produced by the primordial utricles.

In other general respects, the observations upon this utricle, detailed by Mohl, are, as might be expected, minute and accurate. I have not only examined plants which have been long kept in spirits, but also, and much more frequently, such as have been macerated for some time in nitric acid. It is unnecessary to neutralize the nitric acid with carbonate of ammonia, and the section only requires to be washed with water, to obtain the result just as distinctly. Colouring the object with iodine renders it still more distinct, and is, therefore, very important. It is also unnecessary to select parts which have not completed their growth; all that is requisite to obtain the same result is, that they should not have become too hard and dry. I have tried this with many plants; but among them I shall only mention the leaves

of *Allium porrum*, because in the garlics the spherical clear bodies exist, which exhibit an appearance of one cell within another, and have sometimes confirmed observers in the belief that the young cells were contained within the old ones. We shall call them the secondary cells. On making longitudinal sections parallel with, or even perpendicular to, the surface of either the upper green portion or the under colourless part of the leaf, and examining them in a drop of water in the usual way with a sufficient magnifying power, we perceive in the white part the light cells, which appear clear and transparent; in the green part, we see here and there a little of the granulo-cellular matter, which most of the cells contain, and we also find the light, globular, secondary cells. But if the sections are moistened for a few minutes with nitric acid, and then washed with water and coloured with tincture of iodine, the whole is changed. We now see, inside the cells, a sac of a yellowish colour, and almost of the same form as the cells, but more or less irregular, frequently lacerated, more or less detached from the wall of the latter, and also more or less contracted. It is completely filled with the granulo-cellular matter, and when secondary cells are present they are scattered within the sac, more deeply coloured than the sac of the cell, and completely filled with granules. The external membrane of the cell remains transparent, and perfectly uncoloured. But the most remarkable feature exists in the small warty projections on the margin of the sac, which fit into apertures in the external membrane of the cell; between them this membrane appears raised in roundish portions, and sometimes we perceive obscurely-defined laminæ in these tumid spots.

After these experiments, I must express my approval of Hartig's memoir upon the Structure of the Vegetable Cell. The membrane of the utricle is evidently his Ptychode, a membrane which descends into the so-called pores of the external membrane, and is really a distinct membrane; it surrounds the internal contents, but

belongs to the secondary layers as it is coloured yellow by iodine, whilst the outer membrane, Hartig's Eustathe, and the intermediate layer, Hartig's Astathe, are not coloured. Hartig must not be offended at my refusing to adopt these technical terms. They are not only perfectly superfluous, but even retard the progress of science; they form the skins which science must throw off at every moulting period. The inner membrane of the cell, or the membrane of the utricle, belongs, with the spiral vessels, to the secondary formations, and undoubtedly has some relation to the formation of spiral vessels, although not that which Hartig has far too positively asserted. I shall now immediately pass to—

The Life of the Vegetable Cell, together with its Formation, Growth, Development, and Dissolution. By Dr. THEODORE HARTIG. Berlin, 1844. 4.—This memoir requires very careful analysis, which cannot be given in a few words. We shall only make a few remarks upon it here. In the first section—The Life of the Vegetable Cell, during the period of Cell-formation, the author says, *a*, "Origin of cells.—Cells are only formed in the interior of a parent-cell. They are originally simple Ptychodal cells with fluid contents, the cell-sap. In the course of its development, the Ptychode becomes subdivided into an inner and an outer Ptychodal membrane, in this manner a Ptychodal space is formed, which is distinct from the cavity of the cell. A fluid resembling the laticiferous fluid, the Ptychodal sap, is secreted in this cavity from the sap of the cell. In the Ptychodal sap the new cell-germ is formed; this becomes developed into three different kinds of cells, digestive-, propagating-, and colour-cells. The digestive- (Metacard-) cells effect the further elaboration of the sap of the cell. The propagating- (Epigon-) cells develope a new generation of cells, of three different kinds, in their Ptychodal cavity, in the same manner as the original parent-cell. The colour- (Euchrom-) cells form Euchrome (which includes

Chlorophyll) in their Ptychodal cavity, and starch." Then follow observations in which, as regards the contents of the cells, so far as my own investigations enable me to judge, many of the details are minute and correct. In fact, too minute, for these contents hardly appear to me to deserve the name of cells; the most we could call them would be cell-nuclei, cell-vesicles, or, with the author, nuclear corpuscles. They are always of very different sizes and shapes, never equilateral, even when closely crowded, hence they are not formed by internal expansion; they are never distributed regularly, and often appear to be perfectly solid internally, like granules of starch. The secondary cells, as I have denominated them above, are the most regular; they also contain small cellular granules. The granules of Chlorophyll in succulent and water-plants are of a tolerably regular figure, but they appear solid, and altogether of a very different nature from the cells which surround them externally. The cytoblast appears to me to be a granular mass, which is possibly inclosed by a membrane, but this I will not decide; according to the author, it is a perfectly-developed and not a young cell. He makes the following remarks upon it: "There can scarcely be any doubt that the cell-germ of the cytoblast and of the nuclear corpuscles may, like that of the cavity of the Ptychode, become free and capable of further development; but it is equally as certain that the cell-germ does not originate exclusively from this source, because it is also formed in exactly the same manner as within the cytoblast, in other parts of the cavity of the Ptychode of the cell, where there are no cytoblasts. In fact, I believe that, as a rule, the cytoblast does not produce any propagating cells, but that its function is rather the elaboration and conversion of the sap of the cell into that of the Ptychode." If the author believes the latter to be true, he should not say that the former can scarcely be doubted. On the contrary, it is very doubtful, and has not been proved to occur by any of his observations. In all these investi-

gations it would be very desirable that the objects should be carefully distinguished. What applies to the Algæ cannot necessarily be assumed as holding good in the case of the Phanerogamia, and still less, what is observed in Fungi, as the author has done. His observations upon the cells of the ripe and unripe berries of *Solanum nigrum* are valuable, but this is a distinct subject, and one which may be of importance as regards the ripening of the fruit, and it would have been very desirable for the author to have instituted a minute comparison in this point of view. Again, the title, 'The Life of the Vegetable Cell,' says too much. My friend Hartig knows as much of the life of the cell as I do, i. e. nothing. Life is motion, arising from internal excitation, and we are unacquainted with the movements of the fluids in the cell which produce development.

Schleiden says, in his 'Principles of Scientific Botany,' p. 200: "I believe that even in the youngest condition of the cell, a delicate membrane and a substance which is not colorable by iodine may be distinguished; the former of which completely incloses the cytoblasts. Mohl has apparently (Bot. Zeit., 1844, No. 15 et seq.) misunderstood me, in relying upon an expression which was certainly ill-chosen by me, and by which I intended to illustrate this point, when I first published my discoveries. But as soon as this primary membrane of the cell has become even slightly separated from the cytoblast by its expansion, the whole of its inner surface is very frequently found covered with a delicate coating of semifluid (very often circulating in reticularly-anastomosing currents) mucilage, which is sometimes granular, sometimes perfectly homogeneous and pellucid, but may always be rendered visible either by nitric acid, alcohol, or iodine; this is Mohl's primordial utricle." The granulo-cellular mass, called the cytoblast, certainly always appears surrounded by a delicate membrane. At first this mass appears compact, but subsequently it becomes divided, and then the motion of the small granules begins to be visible. In the cells

of the pith of the recently-developed twigs of the willow (e. g.) this mass assumes a tolerably compact form; in twigs of a year's growth it is found diffused, and has formed dotted cells. Now it appears to me, that this membrane becomes applied whilst in a delicate state to the wall of the cell, and in certain parts penetrates more deeply through the secondary deposit, until it reaches the outermost membrane, and in this manner the apparent holes or pits are produced. The prominences seen on the utricle after it has been detached by nitric acid, and which fit into depressions in the membrane of the cell, and the elevations between them, appear to prove this to be the case. The nitric acid probably only acts by contracting the parts and rendering them visible. The membrane inclosing the granular contents, when detached from the walls of the cell, is only rendered of a pale yellow colour by iodine, and at first is not at all coloured by it. From these considerations, it appears clear to me that this membrane is applied to the outer membrane of the cells, and that it is again detached from it by the action of nitric acid, but for this very reason it cannot be a primordial utricle.

UNGER'S *Memoir* in the 'Botanisch. Zeit.,' 1844, s. 498 et seq., *upon the Growth of Internodes anatomically considered*, properly belongs here. The author counted the internodial cells existing in *Campelia Zanonia*, and then compared the number with their length and breadth, whence he arrived at the conclusion, that the enlargement of the internodes is the result of the continuous growth of the new elementary parts, and also that the enlargement of the internodes of the axis arises from both the addition of new elementary parts and the increase of those already existing. He then goes further, and proposes the question of how, and in what manner, the addition of new elementary organs (cells) takes place in the growth of the internodes. He examined a longitudinal section which passed through several internodes, and then found that the formation of

new parts occurs in the internodes themselves and not in the nodes. He moreover says, "If we carefully examine cellular tissue, in which new formations are in progress, we find what is very remarkable, that all the cells are not furnished with walls of equal thickness, but, on the contrary, that some of them are delicately constructed, whilst others are scarcely perceptible. From this we may conclude that, in all probability, the latter are of a later formation, and hardly entertain a doubt that any observer will admit both the fact and the conclusion derived from it." The next question was, whether the separating wall was single or double. To determine this point, the author selected some young hairs which were in the earliest stage of development, from the recently-formed leaves of *Syringa vulgaris*. He endeavoured, by the action of chemical re-agents, to produce a condensation and contraction of the finely granular contents, so as to allow of the more perfect examination of the walls. Dilute mineral acids answered tolerably, but the result was best obtained by first subjecting them to the action of caustic potash, and subsequently iodine. Even then the separating walls always remain simple. Hence the author thinks that this forms the commencement of a subdivision into more cells, and therefore calls this form of cell-growth merismatic, but he is too hasty in his conclusions on this subject. As Unger expressed his dissent from Schleiden's theory of cell-formation, the discoverer of the spermatozoa (or whatever else they may be called) in the anthers of the Mosses, and the ciliary motions of the spores of the Algæ, &c., receives the following reprimand in the 'Principles of Scientific Bot.,' p. 210: "Transverse and longitudinal sections, and a mere glance through a microscope, be this ever so good, are certainly not sufficient now-a-days for making phytotomic investigations."

In the first part of Schleiden and Nägeli's 'Zeitschrift für wissenschaftliche Botanik' (Zürich, 1844), there is a *Memoir*, by Nägeli, *upon the Nuclei of Cells, Cell-forma-*

tion, and Cell-development, wherein Schleiden's theory of Phanerogamia is brought forward. In the second part (1845), we find an appendix, entitled, Definition (*Begriff*) of a cell. The author, after making some remarks upon Schleiden's definition, says: "The idea of a cell signifies that a portion of the organic matters becomes individualised, invested with a membrane, by means of which it is put in relation externally with the absorption and exhalation of matters, whilst internally it undergoes chemical and plastic changes." The commencement is perfectly correct; the idea of a cell signifies that a portion of the organic matters becomes individualised, so that the solid parts form externally an envelope, within which, in part at least, matters exist in a fluid or even in a gaseous state. Whether in all cells a solid body is first formed, does not appertain to the idea, nor has this been proved to be the case by observation. The nucleus of the cell, as it appears to me and to others, is an irregular accumulation of granules or vesicles, and seems more like the mere commencement of a formation, than a primitive formation itself, which here, as in almost every other case originates in a liquid. The author says, with perfect truth, the idea of an organism combines two important forces—that by which it lives, and that by which it propagates itself. But when it is added, that both of these depend upon its being composed of cells, this dependence certainly is not apparent. If it is proved that the motion of Browne's molecules depends upon an internal influence, they are alive, whatever may be their internal structure. The organism requires a reciprocal action of the parts upon each other as organs, which is certainly most easily produced by the movement of fluids within them; but it by no means follows, it is not proved, nay, it is opposed to experience, that it is entirely composed of cells. If it were stated that it is produced from cells, my reply would be, that this is very probable, but nothing more.

In the search for definition of a plant and of the vegetable kingdom, much dependence is placed upon the

absence of nitrogen in the membrane of the cells of plants, and also upon the presence of nitrogen in the animal kingdom. But supposing that nitrogen were to occur in the membrane of several vegetable cells, would the plants for this reason, cease to be plants? Boussingault has shown that a large quantity of nitrogen exists in plants, but where, has not been positively determined. It is reversing the proper method to commence with chemistry in the study of natural history: and this, first, because chemical analysis is the most difficult; secondly, because its resources are inexhaustible, and cannot be regarded in the same light as the latter; and lastly, because it affords us no insight into the intimate structure of organic bodies, as is proved by isomeric substances. The membrane of plants is isomeric with starch, as Payen has shown, and yet the two are very different from each other.

Investigations upon the Growth of Cells. By Dr. SCHAFFNER of Herstein. Flora, 1845, 481.—"If we may be allowed," says the author, "to deduce conclusions from the investigations which have been detailed, the following cells increase by primary cell-formation. 1. The cambium cells (which are subsequently developed into prosenchyma and vascular cells). 2. The cells of the liber, which do not differ materially in their earliest stage from those of the cambium, but form a distinct system. 3. Part of the cells of the parenchyma, to which the cells of the leaf (excepting those of the cotyledons), and the cells of the parenchyma of the fruit of the apple and the plum provisionally belong, i. e. should the absence of secondary cells in them be confirmed." This is of no importance, the point is whether the so-called secondary cells are really such, i. e. are formed from the parent-cell. "By the formation of secondary cells, the remaining cells of the parenchyma increase, as seen, e. g. in the cells of the pith and of the bark, &c." (???) "Increase of cells by division certainly does not occur in Phanerogamous plants." (?)

In an appendix upon the laticiferous vessels, he advises us not to read upon the subject at all, because most of what is stated upon it involves much contradiction; he quotes Bischoff and Schleiden. He has not mentioned my researches. In the first part of my Lectures on Botany, he would have found much upon this subject; and also many figures in the Plates to the first part of my Anatomy of Plants.

Researches on the earliest Modifications of Organic Matter and the Formation of Cells. By M. Coste. Comptes rendus, 1845, 2, 911, 1396.—This memoir principally treats of the animal cell, and tends more by reasoning than experiments to show that the theory of the production of cells by the nucleus is not based upon satisfactory investigations.

The preceding experiments upon the manner in which new cells are formed, induced me to make some extended observations myself. Thus, when our object is to become acquainted with the manner in which cells are reproduced in the Phanerogamia, without confusing the phenomenon with others not appertaining to it, the method of proceeding used by Unger is the best. With this view I caused some bulbs of *Allium cepa* to grow in a hyacinth glass filled with water, and made marks upon the roots which had grown out, with Indian ink, one close to the bulb, another close to the conical apex, and a third midway between the two former. In a few days the roots had grown very considerably, the conical apex not so, as far as was distinguishable, the base had grown but little; the portion between the apex and the middle had grown most. The latter portion was again divided in the middle, and it was found that the part nearest to the apex had again grown very considerably, whilst that next the middle had grown but little. On making a longitudinal section from the mark at the apex to near the upper mark, treating it with nitric acid, and then iodine, a great many short cells were seen near the apex, these were found gradually to

increase in length towards the upper part, and finally became very long. But the cells at the circumference of the root were longer than those in the centre. In all of them the inner membrane was separated from the walls of the cells, and was contracted around the granular contents, which were of a dark brown colour. The sac thus formed assumed the shape of the surrounding cells, the walls of which did not appear at all coloured by the iodine. Each cell contained the globular sac, which I denominated the secondary cell above; it was also of a brown colour, and filled with a granular mass. It was always situated in the longer sac, but in different cells sometimes at the ends, sometimes in the centre, sometimes near the centre. Thus, where the growth was most active, short cells appeared to have been formed, which then became elongated and had completed their growth. I could not satisfactorily perceive any division of cells. I had made similar marks to those upon the roots, on the young leaves which sprouted out from the same bulb; one near the bulb, another just beneath the apex, and a third midway between the two other marks. That nearest the apex remained unchanged; the apex of the leaf, just as the apex of the root, did not grow; that portion between the mark on the apex and the middle had increased but little, just the reverse of what occurred in the roots, in which this was the part which had grown most, whilst that part of the leaf near the base had increased very considerably, whilst in the roots, on the contrary, it had grown but little. A longitudinal section of a marked leaf was then made parallel with its surface, from the base of the leaf at the root upwards, and treated as before. In this case, as had previously been found in that of the root, short but not broader cells were found at the base of the leaf near the root, where the growth commenced, and these increased in length upwards, towards the middle of the leaf. The formation of these short cells and their elongation evidently produces the increase in size of the leaf, as I have already remarked in my 'Lectures on Botany,' (p. 83,) and have

had figured in my Plates (part I, pl. i, fig. 4*b*). There was no appearance of the formation of one cell (secondary cell) from another (parent-cell), and the inner sac remained unaltered, still forming an inner sac, and certainly not becoming external. This is what ensues during the growth of the cells in the parts of the Phanerogamia. The phenomena which occur in the embryo-sac, or in the cells of the Algæ, which, as the remarkable phenomenon seen in the cells of the *Spirogyra* show, perform different functions from the cells of the Phanerogamia, do not belong here, and no conclusion can be drawn from these so-called cells as regards the cell properly so called. The apices of the roots and leaves which do not grow, consist of very short cells, all of which contain a nucleus of considerable size; this, however, as in the other cells of the leaf and root, never becomes developed into a distinct cell.

On the Penetration of the Cuticle into the Stomata. By H. v. Mohl. Bot. Zeit., 1845, p. 1, and Ann. and Mag. of Nat. History, vol. xv, p. 217.—The different statements which have been made upon this subject induced the author to institute some investigations upon it. For this purpose he adopted the method of soaking the sections of the leaves for examination in tincture of iodine, washing them with water, and then submitting them to the action of sulphuric acid. The latter not only heightens the yellow tint of the cuticle when coloured by iodine, but it has especially this advantage, that the cells of the epidermis of most plants are disintegrated, with the production of a blue colour, or entirely dissolved, according to the strength of the acid employed, and the cuticle can then be very readily distinguished and separated from them. The general result obtained from these investigations was, that, as asserted by Payen, a direct prolongation of the cuticle penetrates into the stomata, and runs down between the cells bordering the orifice to the air-cavity, in the form of a tube very highly com-

pressed on both sides. In the opinion of the author, no doubt can be entertained, after careful examination, that this tube is not closed either at the entrance into the stomata, or lower down, between the cells of the orifice. When it has arrived at the inner termination of the stomatic aperture, this tube dilates into a smaller or larger funnel-shaped expansion, which clothes the inferior surface of the epidermis so far as this bounds the air-cavity externally. This funnel-shaped expansion presents some varieties in different plants, which the author details. Thus the cuticle either lines the walls of the air-cavity only, without penetrating into the intercellular passages, or it penetrates into some, or even all, of those passages which are in connexion with the air-cavity. Lastly, the author comments upon the question of the cuticle being a peculiar membrane, different from the epidermis. He believes that it is not so, but that its peculiarity arises from a change in the substance of the external layers of the epidermal cells themselves. Were I to pass hastily over this paper, as the author says is my custom (although not very politely), I should say that the point is not how the cuticle is formed, but whether it is composed of the outer walls of the epidermal cells, and as this has not been shown to be the case, it must be considered as a peculiar membrane until it is so. At all events, the question remains *in statu quo*. But, as in all questions relating to the formation of organic bodies, we must look forward for a complete elucidation of this point, to a clearer insight than has yet existed.

Investigations upon the Cellular Structures which fill up Vessels. By an anonymous Author. Botan. Zeit., 1845, p. 225.—The author first shows that these bodies consist of true cells, or, as he expresses it, that they are phenomena analogous to the ordinary simple cells of plants. These cells are not generally formed while the plant is young; in first year's shoots of *Vitis vinifera* and *Sambucus nigra,* as also in the stems of *Cucurbita pepo,*

the vessels were empty in summer; towards the end of October and at the beginning of November they only contained a small number of cellules adhering to the walls of the vessels; but a month later he found them copiously furnished with both large and small cells. In a fourth year's branch of *Robinia pseudacacia,* the most external annual zone was in a condition similar to that of a first year's shoot of the same plant; the three inner ones were completely filled with cells. As regards their being adherent, he makes the remarkable observation, that the small cells are always attached to the side of the vessel when it is surrounded by cells of woody tissue or the parenchyma of the medullary rays, but never to a wall which is bounded by an adjacent vessel. Moreover he observed that one of these cells always lies in front of the dot of a vessel, which corresponds with the dot of the adjacent external cell. He also believes he has observed that the membrane of the utricle has some relation with the primary membrane (which belongs to the external cell and the vessel, and which closes the two dotted canals), and that in its earliest stage it is an expansion of this primary membrane into the cavity of the vessel. Hence the formation of the inner cell depends upon the activity and development of an external adjacent cell. This is most distinctly seen when preparations of these vessels in *Vitis vinifera* and *Sambucus nigra* are treated with caustic potash. To avoid unnecessary circumlocution, he adds, he cannot avoid assigning names to the objects, especially to distinguish the old cell from the utricular sac, which he denominates the *thylle,* these two composing one compound organ. Considerations upon the formation and development of these and other cells follow. The investigations of the author deserve the greatest attention and careful repetition, for the purpose of either confirming or correcting these observations upon a remarkable phenomenon.

We have received accurate and comparative experiments

on the chemical peculiarities of the vegetable cell, first from Payen, he having previously made his excellent observations on Starch. The whole of these investigations were published in 1842, in his 'Mémoires sur les Développemens des Végétaux.' He first instituted his experiments upon the cellular tissue, which consists of little more than membrane; this was taken from very young parts, e. g. the ovule of the almond, pear, and apple tree, and of *Helianthus annuus;* the delicate membranes formed upon the coagulated drops of fluid which exude from the sections of the vessels of the cucumber, also upon the pith of young shoots of *Sambucus nigra,* cotton-wool after a first and second purification, and the spongioles of roots, and the pith of *Aeschynomene paludosa* (rice-paper). All these substances were repeatedly treated with dilute hydrochloric acid and ammonia, washed with water before each repetition of the process, and lastly exhausted with alcohol and ether. They were then strongly dried, powdered as far as possible, and then burnt with oxide of copper. He found, as the result of the elementary analysis, the composition C^{24} H^{22} O^{2}, which is isomeric with starch. He then gives a simple, direct experiment, by which cellular membrane may be recognised under the microscope. A small section, e. g. of rice-paper, is placed under the microscope in a drop of water; one or two drops of an aqueous solution of iodine are then added, which produce a pale-yellow colour; and lastly, a drop of concentrated sulphuric acid. The membrane is then first coloured blue, and is finally wholly dissolved, so that only yellow traces of the matters which were contained in the membrane remain. A better method than this one of Payen's, is to place the section for microscopic examination in a drop of water, then to add a drop of nitric or hydrochloric acid; to let the whole remain for about two minutes, then to wash the section with water, and to colour it with tincture of iodine. The membrane itself now appears perfectly colourless; sometimes it is slightly bluish here and there, from a portion of starch which is dissolved, and all the foreign matters are rendered deep

yellow, so that they are readily distinguishable from the membrane. The experiments upon the leaves of *Allium porrum* and the roots of *Allium cepa*, which have been already detailed, were made by this method. It must be remembered that the starch-granules are here dissolved; hence, if it be required to observe them, no acid must be used. If this experiment be reversed, and the section be first examined with tincture of iodine, the starch is easily recognised; but no nitric acid must be added, because it dissolves the iodised substances, leaving the membrane, which cannot now, at least very readily, be recognised and sketched. But by this method the membranes of the utricles, the contents of which are dissolved, are distinctly seen within the cells. Caustic potash and caustic soda also remove the contents of the membranes, and leave the latter, although in an indistinct state. But I must return to Payen's investigations. He next examined, by elementary analysis, the following structures, after having exhausted them with several solvent media. The leaves of Endive and *Ailanthus glandulosa*, the internal cellular tissue of *Agave Americana*, the spiral vessels of *Musa Sapientum*, the radicles of maize; portions which had resisted the digestive process in animals, the albuminous tissue of maize and corn, the albumen of *Phytelephas*, and the kernels of the date; the hairs of the seeds of the Virginian poplar, the vegetable membranes of which the nest of the wasp is constructed; the heart-wood of the oak, the wood of the Coniferæ, also *Conferva rivularis* and *oscillatoria*, the membrane of *Agaricus edulis*, probably *Ag. campestris* L. He also makes use of the name *Scariola*, as well as "*Chicorée endivie.*" How can any chemical investigations be of use, if the object which has been examined is not definitely stated? Then follow investigations upon the substances existing in the cells which also contain nitrogen. I have quoted these details here for the purpose of introducing a memoir by *Fromberg, on Cellulose*, given in the 'Scheikundigen Onderzoekingen,' 2 D. s. 36, and which is extracted into the 'Journ. f. praktische

Chemie,' 32, Bd. s. 198. He subjected *Cetraria Islandica* and *Agaricus albus* to elementary analysis, and his results agree tolerably well with those of Payen. He then makes the following remark: "I am also satisfied as to the perfect accuracy of his experiments, yet I cannot deny that I am astonished, first, at not finding it stated anywhere that he previously determined the amount of ash, except in his first memoir (Annal. des Sciences Natur., 2 sér. t. ii, p. 27), since even if he had not found any ash present, he ought to have mentioned it; moreover, since none of the substances mentioned by myself as having been analysed were perfectly free from the so-called incrusting matter, and since the results of Payen lead to the same conclusion, which is explained by the intimacy with which these substances permeate the primary cellular tissue; and again, since silica, which is so generally diffused throughout the vegetable kingdom, would very probably have entered into the composition of these matters, it does not appear possible that the vegetable structures subjected to examination could have been perfectly free from silica." This suggestion is quite correct. Payen gives the amount of ash contained in the vegetable structures when not yet separated from the matters deposited upon the cellulose. We thus find that 10·80 p. c. of silica are stated to exist in the leaves of Endive, but none in the leaves of the same plant when exhausted of everything but the cellulose. This is very improbable, for the amount of silica in the leaves of the Graminaceæ, before purification, is stated to be 12·25; but I find no analysis given of the leaves after purification. But in this case the amount of silica existing in the cellulose must be very large, for the incinerated leaf is so completely converted into silica, that all its parts can be accurately distinguished under the microscope; a remarkable phenomenon, and one which still requires careful investigation, because it is opposed to what we know regarding cellulose.

In the same 'Scheikundige Onderzoekingen,' l. c. p. 62, 'Journal f. Prakt. Chemie,' l. c. p. 204, we have an

Analysis of the Seeds of Phytelephas, Ruiz et Pavon (*Elephantusia* Willd.),* by BAUMHAUER. He gives his results in the following words: "Our results show distinctly that the perisperm of *Phytelephas* does not, as Payen states, consist of pure cellulose, contaminated with albumen, two nitrogenous substances, silica, two fatty bodies, and salts; but that, in addition to these matters, of which the albumen, the two nitrogenous substances, and the two fats are in extremely small quantity, an additional deposited substance occurs, which differs but very slightly in its per centage composition from cellulose."

We shall take this opportunity of subjoining the observations which have been made upon Starch during this period. First:—

Description and Figures of some remarkable Forms of Granules of Starch in the Root of Sarsaparilla, and in the Rhizome of Hedychium Gardnerianum. By G. BISCHOFF, Bot. Zeit., 1844, p. 385. The granules in the former root are very often of a hemispherical or half-ellipsoidal form, moreover they are united by their bases, or there are four or more granules connected together in a regular manner. These various forms are accurately described and figured. The author compares them to the combinations presented by many kinds of pollen-granules, they might also be compared with a tricoccous or tetracoccous capsule. Several others might be added. I have met with a form in which a small angular grain occupied the centre, and the other five were so arranged around this, that the whole figure somewhat resembled a regular pentapetalous flower. The author remarks that the concentric lamination was not perceptible in daylight, but it was distinctly so by subdued lamp-light. The author also found potato-starch to consist of a combination of two granules. The starch existing in the rhizomes of the

* One botanist considers that the alteration of the word *Phytelephas* into *Elephantusia* would be a very unnecessary change. But *Phytelephas* signifies a vegetable elephant, and such a zoophyte is something too terrible.

Scitamineæ is singular enough. The granules are cylindrical, and either curved or bent at an angle; they are sometimes club-shaped, or of various other forms, some of which resemble a pileate Fungus, and in consequence of their being contracted between the rings, they distinctly exhibit their laminated or tunicated structure, each main-ring again exhibiting a larger or smaller number of exceedingly delicate, parallel, curved, transverse markings. The larger segments undoubtedly denote the separate granules of the composite structure, and each of these is again finely laminated.

On the Starch of Gloriosa Superba, L. By JULIUS MÜNTER. Bot. Zeit., 1845, p. 193.—The form of the granules of starch which exist in the rhizome of this plant, is sometimes that of a perfect sphere or ellipse; but by far the larger number of granules are bounded by one or more plane surfaces, which sometimes meet at an acute, sometimes at a right angle. If we divide an egg, says the author, through its middle, at right angles to its long axis, we obtain two kettledrum-shaped halves, these accurately represent, on a large scale, the appearance frequently exhibited by the starch of *Gloriosa*. Other pieces resemble that form which we should obtain on dividing an egg anywhere parallel to its longitudinal axis; other forms again represent sections of a sphere, i. e. pieces which are bounded by two plane surfaces intersecting each other at an angle of 120° and one spherical surface. Sometimes we find three plane and one spherical surface; and lastly, we have also pure stereometric forms, pentahedra, hexahedra, and octahedra. Occasionally the granules are of an indefinite form, which does not admit of description. *Maranta bicolor* Kerr, and *Jatropha manikot*, also exhibit pentahedral granules of starch. The author brings these forward as a proof that even an organic compound may assume a crystalline form, and from this consideration he applies to them the term glandules. It is then found that these glandules become disintegrated when removed from the cell and placed in water, upon

the object holder, which is not usually the case, for in other plants the granules retain their connexion. The author then passes to the investigation of how these granules of starch are formed and developed. We might at first imagine, says he, that as in crystallization, the amylaceous plasma (the analogue of the saline solution) is deposited upon the little globules which first separate, and that in this manner, by the continuation of deposition upon their outer surface, larger granules are formed. We might add to the author's explanation that the granules are formed around a nucleus, as is usually considered to be the case from the manner in which crystals are formed. According to the author's view, the twin granules of the nucleus of the one individual must lie close beside the nucleus of the other individual, and nearly in that plane in which both are connected, or near the parchment of the kettledrum, if the above comparison is retained. This is not the case, for the nucleus is situated in the bottom of the kettledrum, at the end of the elliptical or spheroidal section (this is also shown by the figures given by Bischoff.) The author then proceeds to the question whether the pressure of the cell inclosing them might not produce an angular form. But this is not the case, for the granules have an angular form, even when they do not completely fill the cells. It is evident, says the author, from what we have stated, that pressure cannot be the cause of the formation of the gland-like collection of starch. From all this, he adds, all that remains is the prospect of a peculiar formative process in the vegetable kingdom. Regarding the vegetable cell, we know with perfect certainty that the concentric appearances, as seen e. g. in the stony tissue, as it is called, of the pear, &c. arise solely from the centripetal formation of layers. But nothing is opposed to the view that the layers of the granules of starch also are formed by centripetal, i. e. internal deposition; on the other hand, this hypothesis is supported by the fact that the nucleus, as it is called, of Fritzsche, or the central cavity of Schleiden, contains much water, and is, as it

were, gelatinous. For as soon as sulphuric acid is added to the granules of starch, under the microscope, and it begins to remove the water from the inner layers, a bubble of air appears in the place of the nucleus; the same occurs when the granule of starch is heated; in fact, even when fresh starch is dried at the ordinary temperature of the air. The latter phenomenon, which was not observed by either Schleiden or Fritzsche, thus also explains the formation of the fissure near the nucleus. But if, as appears from these observations to be the case, the nucleus and the layers nearest to it, contain more water than the outer ones, i. e. if they are softer and less consolidated than the outer layers, we might assume with tolerable certainty that the central layers which surround the nucleus are the youngest, and the peripheral ones the oldest. Now, if this hypothesis be retained as the most probable, there is no difficulty in explaining the spot where the nucleus should be found. Accordingly as the layers happen to be thick or thin, the nucleus must be situated more or less excentrically, in fact it must be excentric in the large globules. For as soon as the centripetal formation of the layers was uniform in all parts of the inner surface, a condition would occur, which would prevent any further development, because the walls being everywhere of equal thickness, the transmission of new nutritive matter would be prevented, whilst this condition would never occur if one part of the granule were thinner than the rest. When the walls of the cells are thicker, other means come into play in facilitating the access of nutriment, viz. pore-canals. The author moreover adds: "We must rest satisfied for the present, with the conclusion which has been arrived at negatively, that a process similar to that of cell-formation must be admitted to occur in the case of the granules of starch, the nature of which must form an object of future investigation." It is very pleasing to find that the author has differed from the ordinary explanations of the formation of starch. I quite agree in his opinion, that the granules of starch are formed from

without inwards, and that this is produced by a peculiar process of formation, which certainly resembles the process of cell-formation, but is not always perfectly regular. I should attribute the eccentricity of the layers around nucleus, solely to this irregular formation. The granule of starch apparently absorbs moisture on all sides, and then developes the layers internally. A similar internal formation is also the cause of the regular separation of the granules in the root of *Sarsaparilla*, which then finally passes into the external crystalline form of the granules in the tubers of *Gloriosa superba*, as was first discovered by the author. All the granules existing in the same tuber, even those close together, are not of the same form; some are more rounded externally, some are rounded on the sides, bounded on the others by two planes, because originally they separated from each other at that part, others are bounded on all sides by plane surfaces, like the central grain in the compound form, presented by the granules in the root of *Sarsaparilla*. I should always ascribe these crystalline forms to the internal separation of granules, to which view I was led by the granules of starch in the bulb of *Ornithogalum (Myogalum) nutans*. But the author will publish his own investigations upon that point. He then adds some remarks upon Schleiden's observations on this subject in his 'Systematic Botany.' The amorphous granules of the seeds of *Coriandrum minus* arise from desiccation; this is also the case with the cup-shaped granules of starch in the rhizome of *Iris pallida*. Schleiden, in opposition to Meyen, incorrectly denies the occurrence of discoidal granules in the Cannaceæ; for in *Canna variabilis* for example, we find only such. The arrow-root of commerce presents considerable differences; the author details them. Most of the commercial article is obtained from *Tacca pinnatifida*; the same statement applies to sago. He could not detect any cup-shaped granules in *Rad.* (*stolones*) *Iwarancusæ*, such as Schleiden states to occur. I look forward to the continuation of the author's accurate and valuable investigations.

Observations on the Formation of Starch. By C. MULLER; Bot. Zeit., 45, 833.—They were instituted upon *Chara crinita*, and, according to the author, they exhibit the following points: it is the cytoblasts which are transformed into starch, and this only occurs in cells which are mature.

Note upon the Phenomena produced by the Transmission of Polarized Light through Starch. By M. BIOT. Compt. rend., 1844, vol. i, p. 795.—In his previous experiments the author examined the granules of starch by means of two prisms, one of which was placed above the other, and crossing it at right angles; on the present occasion he changed the apparatus by so placing a plate of mica between the two prisms, that the median line between the two axes formed an angle of 45° with the principal sections of the prisms. The mass of the granule is then seen illuminated with bright colours, the tints of which vary with every change of position, and with the direction in which the luminous rays are transmitted; so that, as in a picture, all the curves of the outline, all the undulations of the surface, all the peculiarities of the structure, and the slightest accidental alterations become sensible. Probably under some circumstances this means may prove of the utmost value; but in the present case, considering the great and accidental varieties in the structure of the granules in starch, it is perhaps of minor importance.

We shall now pass from cells to vessels. In the 'Annual Report,' for 1841, I made some observations upon the work of C. H. Schultz, on Cyclosis in plants. The author has replied to them in a book which we shall allude to presently, viz.: 'Discovery of the True Nutritive Process of Plants,' Berlin, 1844. He there says, with regard to my remarks, p. 54: "There are two main points to be considered: first, whether I have correctly denominated the vessels of the liber, vessels of the vital fluid (*lebenssaftgefässe*); and, secondly, whether the currents of fluid in *Commelina cœlestis* consist of a circula-

tion (rotation) of the granules without any trace of anastomosis, as in *Vallisneria*." He has distorted my statement, and I must therefore briefly repeat my remarks. Schultz was the first to detect the motion of the fluids in the so-called proper vessels (*vasa propria*), he also first gave good illustrations of these vessels. But to carry out his hypothesis regarding Cyclosis, he has attributed these vessels, which he denominates vessels of the vital fluid (laticiferous vessels), to many plants in which they do not exist. They are said to occur in the bark of many trees, as the birch, but I only find vessels of the liber in it, and no one has seen them in it, even the author himself only represents their transverse not their longitudinal section, thus we are ignorant as to whether he has really seen them or not. This is most striking in *Commelina cœlestis*, in the stem of which plant, near the spiral vessels, ramified laticiferous vessels are said to pass out and spread over the adjacent cells. He has given a figure of this. But I find, besides the spiral vessels, merely rows of parenchymatous cells, in which granules circulate as in the cells of *Vallisneria;* next to them, are more rows of broad cells, in which currents of fluid are visible, but they are certainly not inclosed in vessels. Therefore there is no trace of ramified vessels. The result is, that the motion of the fluid in the so-called laticiferous vessels is the same kind of motion as had been previously found in plants, namely, as the circulation in the cells of plants, discovered by Corti, which was first accurately observed by Meyen in *Vallisneria*, and the currents of fluid which Robert Brown first observed in the hairs of *Tradescantia*. The motion of the liquid in the articulations of *Chara* is of the same kind. The author makes the following remark among others: "It is to be regretted that the author should have been able to gain so little by the most earnest exertions and sacrifices to solve this problem, that he has rather misunderstood it altogether, and by useless opposition to the evolution of truths, the great importance of which was first recognised abroad, deprived himself the renown of having aided in their

promotion." An example of the incomprehensible arrogance of the author who is bound to a fixed idea. The Academy of Paris certainly awarded him the prize for his Memoir upon the proper vessels, for which no one will censure them, but they declared at the same time, that they do not participate in his views. No academy can test the accuracy of the individual details which are contained in the prize-essays, nor could the Paris academy do so in the present instance.

There is an analysis of the milky juice of *Asclepias Syriaca*, by the same author, in the 'Flora,' 1844, p. 374.

Phytological Studies. By M. le Comte de Tristan. 4th Mem. *Researches upon the Laticiferous Reservoirs and Canals*, Ann. des Sc. Nat., 38, t. i, p. 176.—This memoir is directly opposed to Schultz's views. Some parts of plants do not contain any laticiferous vessels, hence they cannot serve for nutrition. On the properties of the latex. Varieties in the laticiferous vessels. It is impossible to condense this memoir into the form of an abstract.

STEM AND ROOT.

On the Dependence of the Increase of Thickness of Dicotyledonous Trees, on the Physiological Activity of the Leaves. By H. Mohl. Bot. Zeit., 1844, p. 89.—According to the theory of Dupetit-Thouars, says the author, the lateral growth of the stem is in connexion with the expansion of the buds, therefore with the formation and development of new leaves, and depends upon the circumstance that the buds, in the same manner as a germinating plant, send out radical fibres which descend between the bark and the stem, and form a new layer of wood; according to another theory, the lateral growth of the stem depends upon the activity of the leaves, because they prepare the nutritive fluid, which is applied to the formation of new woody layers. To decide this point,

the author measured the circumference of some trees, which were about eight years old and in an active state of growth, at various periods from the commencement to the end of the vegetating season, and calculated the mean daily increase in the circumference of the stem for each of these intervals of time. The trees were, *Gymnocladus Canadensis, Gleditschia macracantha, Tilia argentea, Populus Græca, Pavia lutea*, and *Morus alba*. A table of the increments is added. The following details are selected from the author's remarks upon his experiments: On the 22d of June the terminal buds of *Pavia lutea* were already formed, but the lateral growth, instead of ceasing, from the above period to the 22d of August, somewhat increased; it then diminished to a small amount. From the 2d of March to the 22d of June, hence before the development of the terminal buds, the circumference of the stem increased 11·8 millimeters; from the 22d of June to the end of the year 16·2 millimeters; so that by far the greater proportion of the increase occurred during that period in which no leaves were developed. The same was found to be the case, although less strikingly, in *Gleditschia* and *Gymnocladus*. Hence the author draws the conclusion, that these observations are directly opposed to the theory of Petit-Thouars. Valuable as they are in themselves, the adherents of Petit-Thouars will not rest satisfied with them, but will object that the roots of the buds, between the bark and the stem, which cause the lateral expansion of the stem, would be small and delicate at the commencement, but that they increased with the activity of the leaves, and in this manner augmented the thickness of the stem. The author adds, that the circumference of the stem also increased, although to a small extent only, when the buds began to enlarge and expand. Hence he thinks that nutritive matter, prepared the preceding year, is applied to the first expansion of the stem in the spring, without the leaves preparing it. Why not? Although it appears determined by numerous experiments, that the leaves serve for the

preparation of the nutritive fluid, there is at present no ground for limiting this preparation to the influence of the leaves alone, if the observations definitely indicate another mode. Lastly, against Agardh's view, that trees grow principally in length during the first half of the summer, but principally in thickness during the second: which is not in conformity with observation.

On the Growth of Internodes, considered Anatomically. By Professor UNGER. Botan. Zeit., 1844, p. 489.—This memoir has already been spoken of at p. 230. It was necessarily brought forward there in connexion with the origin of new cells by division, a mode of formation which I should confine to the Algæ alone. Here we have to notice the general growth of the parts, of which the author very modestly says, that in one special instance—i. e. *Campelia Zanonia*—it takes place not only by the formation of new cells, but also by the increase of those already formed. This law might, in truth, be extended to all the Phanerogamia at least.

In the 'Comptes rendus,' 1844, t. i, pp. 899 and 972, we have the fourth notes relative to the protest of M. C. Gaudichaud, of which we have already spoken.

Continuation of the Anatomical and Physiological Researches upon some Monocotyledons. By M. MIRBEL. (Second Memoir.) Compt. rend., 1844, ii, 689.—In this memoir the author gives a very accurate description of the stem of *Dracæna Australis* (*Cordyline Australis*), as regards its internal structure, and especially the course of the vascular bundles. He endeavours to prove that the latter arise from the root, and from the inner wall of the stem. He has not only described the stem when perfect, but also when young, and this with great care. I first expressed my views on this subject to the Congress of Italian philosophers at Milan, and they are published in the 'Atti della sesta reunione degli Scienziati Italiani

tenuta in Milano,' Milan, 1845, vol. iv, p. 511; more in detail in the 'Flora,' 1845, p. 272; also in my 'Lectures on Botany,' part ii, Berlin, 1845, p. 309. The Date-palm is the subject there treated of. In germination, the embryo or the cotyledon becomes elongated, as is usual in the Monocotyledons, and splits into a sheath, from the base of which the stem grows upwards and the root downwards. The former, which is surrounded by the sheath, contains within it a small tuberous body, consisting of parenchyma and delicate spiral vessels passing round it; above, it immediately forms a bud, consisting of leaves only, as in the Monocotyledons generally. The leaves acquire considerable length, whilst the stem remains as an almost spherical tube. If it be examined at the end of several years, about six or eight, its section exhibits a nucleus, which is throughout traversed by a plexus of vascular bundles, which interlace in every direction. The nucleus is surrounded by a cortex of parenchyma; at the upper part, beneath the bud, there is also a layer of parenchyma forming a cortex, through which vascular bundles pass from the nucleus to the leaves. Thus the young Palm perfectly resembles a *corm*, which only differs from a true bulb in the absence of the fleshy scales. On making a section of the tall part of the stem of a Date-palm, we find a number of vascular bundles traversing it longitudinally. The nearer they are to the circumference, the closer they are together; and at the very circumference they are most closely crowded, whilst towards the centre they are more scattered, more surrounded with cellular tissue, and they are most scattered at the very centre. On closely examining the woody bundles, we find that they are by no means parallel to each other, but interlace in various ways, forming, however, but very small angles with each other. Hence the stem of a Palm is a longitudinally extended corm.

Neither Mirbel nor Gaudichaud have noticed this bulb-like condition of the young Palm-stem, nor have they

definitely alluded to the fact that the Palm grows at the summit only, and that the vascular bundles arise from the interior solely at that part, and grow towards the leaves. Hence I cannot agree with Gaudichaud's opinion, that the vascular bundles arise from the leaves, although he has often quoted me amongst a singularly-enough selected series of authors who are of his opinion. Neither, on the other hand, can I agree with Mirbel, in considering that vascular bundles arise from the interior of the stem. The growth takes place at the summit only, and there the vascular bundles come out from the interior.

Gaudichaud's "Memoirs against Mirbel," are in the 'Compt. rend.,' 1845, i, 1375, 1436, and 1677, and ii, 99, 201, and 261; the memoir upon the Stem of *Ravenala*, in the same year (ii, 391), must also be referred here.

Dr. v. Martius has written a paper *Upon the Process of Growth in Palms, especially as regards the Course of the Fibres in the Stem*, which was published in the 'Gelehrte Anzeige' of the Royal Academy of Sciences of Bavaria, for February, 1845.—The author communicates his results to the Academy of Sciences at Paris; hence they are given in the 'Compt. rend.,' 1845, i, 1038. Gaudichaud has expressed himself strongly upon and against them (p. 1207). Mirbel also is dissatisfied with them. This was to be expected; he who takes the middle path is repulsed on both sides. The vascular bundles, says the author, originate at the summit of the growing point, in the nucleus of the bud or "*phyllophore*" (according to Mirbel), in the substance of the more recent cellular tissue which is in course of development, and which here forms a peculiar layer, coating the older and subjacent parts like a mantle; the recent ones being always formed externally to, and more or less above, those already developed. This is explained in the subsequent parts of the memoir as follows:—As the young plant, even in its first stage after germination, is furnished

with conical sheathing-leaves which arise from the periphery of the axis, and these, as well as all the subsequently formed leaves, derive their vessels from the axis, the very earliest development of vessels must be peripheral; and this method of succession is preserved, as long as any leaves continue to be formed. Moreover, the upper end of the vascular bundle, says the author, tends towards the base of the leaf, the lower end becomes elongated obliquely downwards in the form of a delicate filament, consisting of parenchyma, but which never extends into the root. The spots from which the vascular bundle arise at the summit of the bud, are organically predetermined: they are there placed with their upper ends converging obliquely towards the centre, and become elongated in both directions—i. e. grow both downwards and upwards. The spot at which the upper end of the vascular bundle passes to the leaf, is situated either on the same side of the stem as that in which the course of the vascular bundle is chiefly included, or opposite the point of origin of the vascular bundle, obliquely as regards the diameter; in which latter case, the vascular bundle traverses the entire stem obliquely. As the summit increases in length and thickness, each vascular bundle crosses another bundle, either in the interior of the stem or nearer to the periphery, at the point where, either ascending almost perpendicularly, or suddenly taking a horizontal direction outwards, it enters into the leaf. These are, undoubtedly, the most valuable remarks which have been made upon this subject, and I am glad to find that they confirm what I have stated previously, though less completely. Still I must confess that I am in doubt regarding the growth of the vascular bundles upwards and downwards. The author's explanation does not contain any proof of the occurrence of this growth in both directions. In my opinion it always occurs upwards, but in the same manner as is seen in the corm at the base of the young stem, except that the bundles cross at smaller angles as the growth of the stem pro-

ceeds. Some of the bundles may occasionally diverge more considerably, as the author and Mirbel agree in stating. I have no doubt that here also new vascular bundles are formed between the old ones, which certainly takes place as in Dicotyledonous trees.

On Gaudichaud's Theory of the Merithals. By Professor GUIS. MENEGHINI. Giornale Encyclop. Italiana, vol. i, p. 17.—This memoir, which was written as early as 1843, at the time of the meeting of the Congress of Philosophers at Lucca, must have contributed much to draw attention to Gaudichaud's system. The author sketched the elements of this system, which consists in the unity of the axial system of the plant with the appendicular system, the plant being regarded as composed of phytons, intermediate forms, so to speak, between the stem and leaf. The author admits this system as established, endeavours to illustrate it by analogy with animals, and considers that it must have the greatest influence upon organography. It would have been more desirable that the author, with the acuteness he possesses, had investigated the whole theory more closely. He would then have seen that the exposition of the system rests upon an arbitrary assumption, which can only produce hypothetical results. That the radicle of Dicotyledonous seeds, of the Grasses and Cyperoideæ, is the future stem, has been known for thirty years; but this is not the case in other Monocotyledons. That all parts of an organic being are originally one, no one can doubt, but that the latter is directly developed into these parts, and that the developed leaves, e. g., do not constitute the entire stem, is evident on the slightest examination. The author states his explanation of Gaudichaud's system to be as follows: The fibres neither ascend nor descend; they are formed in the previously-existing cellular tissue, by a gradual conversion of the cells of the parenchyma; the organization of the fibres is determined by the currents of the nutritive fluid and the descending fluids (sap);

the mechanical action of these, and the materials which they bring with them, contributing to it, &c. But this conversion has not been proved to occur; in all probability it is entirely false, and the currents of a fluid may become suddenly changed; in the germinating cotyledons of the Monocotyledons, when emitting radicles, they pass suddenly upwards into the stem, and downwards into the root. But it is perhaps unfair to criticise the author from an old memoir, as since that time he has proceeded with his investigations, and we have still much to expect from him.

New Researches upon the Development of the Axis and Appendages of Plants. By M. C. Naudin. Annal. d. Scienc. naturell., 3 sér. vol. i, p. 162.—These observations are in general accurate and valuable, although they are not new. The leafy parts (appendages), says the author, are the lateral products of an axis, which at first consist of cells only; they also at first consist of cells only, not containing vessels, and the apex of the axis, the centre of a bud, exhibits a tubercle (mammelon) which is in connexion with the pith. The second part of my Select Anatomico-botanical Plates contains many figures which show this more distinctly than the author has done; but so it is, our labours run parallel with those of foreigners, yet we are generally a little before them. But no; the author is actually acquainted with Duchartre, Guillard, and Schleiden, who have investigated this subject. Recently, in the second part of my 'Anatomy of Plants,' the plates contain further illustrations of this subject. What he states of a few Monocotyledons only, viz. that the spots, where the vessels arise, are denoted by a modification of the cellular tissue, applies to most plants, and has also been illustrated in the part of my work alluded to above. The distinction which the author makes between the axis and the foliaceous parts, viz. that the former grows at the extreme point, whilst no addition takes place at the extremities of the latter, is

not perfectly correct, for no addition is in fact made to the very extremity, or external circumference of the axial parts, any more than to the apex and the upper end of the borders of the leaves. The author confounds this with another subject, namely, that the leaf appears and is developed before the petiole; and in support of this view he quotes Morren, who (in opposition to me) has asserted that this does not occur in the aquatic plants, e. g. *Hydrocharis morsus ranæ;* but when the entire plant is examined, the commencement of the leaves is distinctly seen before any trace of the petiole can be distinguished. The author's remarks upon the development of Monocotyledons are very imperfect. He only treats of the bulb of *Narcissus pseudo-narcissus*, and that in a very superficial manner. He might also have seen very strikingly, in the first part of my 'Select Anat.-botan. Plates,' that the vascular bundles are continued from the stem into the root. His idea of distinguishing a spadix from a spike is to the purpose; thus, in most cases, the summit of the bud is covered by leaves, whilst there it grows up naked.

Micrometric Researches upon the Development of the Elementary Parts of the Annual Stems of Dicotyledons. By M. G. HARTING. Ann. d. Sc. Nat., 3 sér. vol. iv, p. 210.—It is difficult to give an extract of this extensive and valuable memoir, without exceeding the limits of a Report like the present. The author only treats of the annual shoots of Dicotyledonous plants. First, of the method and means adopted in his micrometric investigations. Then of the opinion that an annual shoot may be regarded as composed of several individual internodes (mérithals) of different ages, but having the same original structure, so that, by the examination of the various internodes of the same shoot, we may conclude as to the changes undergone by any internode in the course of its growth. The youngest internode of the shoot, it is well known, is the last, and even a superficial examination

shows, that the lower internodes first cease to grow. Investigations upon the growth of the shoot of *Tilia parviflora* follow, arranged in tables; these include: increase of the individual internodes in length; increase of an individual internode at different ages; increase of the pith; multiplication of the cells of the pith; increase of the longitudinal and transverse diameter; of vascular and liber layers; transverse diameter in proportion to the longitudinal; parenchymatous layer of the bark; number of rows of cells, proportion of the diameter of this layer to the diameter of the internode, increase of the cells of this layer in comparison with the increase of the cells of the pith; Schleiden's callenchymatous layer,* i. e. the layer of remarkably long cells, which exists beneath the epidermis in many plants; number of cells in the peripheral layers. We next have similar investigations upon *Humulus Lupulus*, as also upon the nucleus (cytoblast) in the cells of the pith, the corpuscles existing in the layers of the liber, and the growth of a shoot, which had been deprived of its leaves at the apex. Again, investigations upon the shoots of *Aristolochia Sipho, Phytolacca decandra*, and *Sempervirum arborescens*. Then follow the results: 1. The growth of each internode depends upon the formation of new cells, the expansion of the cells, and the thickening of their walls. 2. The multiplication of the cells takes place in three directions: in that of the radius—radial growth; in that of the periphery—peripheral growth; and in that of the axis—longitudinal growth. 3. The radial multiplication only occurs in the buds. 4. This multiplication is produced by means of cross septa, which are formed in the previously existing cells, without the latter becoming subsequently absorbed; the subdivisions thus formed continually become more and more isolated, in consequence of their expanding on all sides. 5. The expansion of the cells in the radial direction is uniform and equal, so that the diameter always

* "A term as elegant as it is superfluous," as Schleiden once said against me on a similar occasion.

retains the same proportion until the formation of wood occurs. 6. The lignifying layers (vascular layers and liber) do not begin to expand in a radial direction until the fibrous cells have begun to acquire thickness; but then with a force which exceeds that with which the pith and the parenchyma of the bark expands. 7. During this period, the cavities of the cells and vessels expand uniformly, and this also still takes place after the thickening of the fibrous cells has commenced. The increased space which the vascular and prosenchymatous layers occupy in the old segments, must be ascribed to this increase in thickness, not therefore to deposition upon the inside of the wall. The author says in a note, that the development of the fruit in the Drupaceæ, and of the albumen in the seeds of some Monocotyledons, shows, that the increased thickness also arises from deposition upon the outside of the wall. Must the expansion necessarily arise then from a thickening of the walls? The interstitial growth of cells and vessels, which undoubtedly takes place in old stems, indicates an expansion without any thickening. 8. The lateral expansion of the cells composing the different layers, usually takes place (at least in the pith, in the parenchyma of the bark and of the epidermis) with the same force in all directions. But this law is liable to exceptions according to the activity of growth. 9. In the stems of those plants in which no central canal is developed (*Tilia* and *Aristolochia*), the cells constituting the pith, the liber, and the parenchyma of the bark, do not multiply peripherally, but only in the direction of the longitudinal axis. The peripheral multiplication is only perceived in the epidermal and callenchymatous layers. 10. In the plants just mentioned, neither the number of the vascular bundles, nor, consequently, that of the vessels increases. The diameter of the latter increases in proportion to the expansion of the vascular layers. 11. In those plants, on the contrary, in which a central canal is developed, the cells of all the layers multiply peripherally, as is also the case with the vessels. This multiplication, in the author's

opinion, causes the absorption of the fluids in the internal cells, and their desiccation, which explains the origin of the inner cavity. 12. When canals containing gum occur in the pith or in the parenchyma of the bark (*Tilia*), they increase but little in diameter during their growth, but they multiply, and when the elongation is completed, they again diminish and become thickened. They already exist at the very earliest period. 13. In those stems in which a central canal is not formed, the increase in breadth depends upon the radial expansion of the cells, excepting in the layers of the callenchyma and the pith. In those stems in which a central canal occurs, the part which the multiplication and expansion of the cells takes in its formation, is variable. 14. This is also the case in the longitudinal growth. 15. The longitudinal multiplication of the cells, as also their expansion, takes place simultaneously at all points of the internode, but in those internodes which are still elongating, the cells of the pith, of the parenchyma, of the bark, and of the epidermis at the apex of the internode, are shorter than those at its base, and the latter again are shorter than those at the apex of the adjacent older internode. When the expansion of the cells at the base has ceased, that of the cells at the apex still proceeds for some time. 16. The smallest cells multiply most, hence the epidermal cells more than those of the parenchyma of the bark, and the latter more than those of the pith, but no definite proportion is observable. 17. Whilst the internode is still very young, the growth takes place principally by the multiplication of the cells only. When the internodes of a plant, after they have acquired their full length, are of slightly different lengths (*Tilia*, *Humulus*, and *Aristolochia*), the numbers of the cells of the pith and bark, in the younger internodes, form a geometrical progression. Moreover, the younger the internodes are, the less they grow, and when the growth is accelerated with advancing age, it observes a geometrical progression. All this shows that the multiplication of cells takes place in geometrical progression. For

instance, each cell subdivides into two, and each of these again into two more, and so on. As the internodes become older, the growing process becomes still stronger, because the expansion of the cells is then combined with their increase in number. The growth decreases gradually at last, because after the increase in the number of cells formed has ceased, the expansion still continues to some extent. 18. Hence three principal periods may be distinguished in the growth of the annual shoots of Dicotyledons: 1st, that in which the internode still constitutes a part of the bud, and where the increase in the number of cells is only radial; 2dly, that in which the internodes increase both in length and breadth, and this again, *a*, arising from the increase in the number of cells only, or *b*, from simultaneous increase in the number and the expansion of the cells, or lastly *c*, from the expansion of the latter alone; 3dly, that in which the growth in the axial direction has ceased, but where the lateral expansion still continues. 19. Since the longitudinal diameter of the cells in those internodes in which the elongation has ceased remains the same, the various different lengths of the internodes must arise solely from the formation of a larger number of horizontal layers. The author ascribes the differences which are perceptible, when the effect of season upon growth is considered, to this circumstance, sometimes more, sometimes fewer of these layers being developed. 20. In the cells of the pith and of the parenchyma of the bark of the youngest internodes, in which the growth occurs slowly from the multiplication of cells, we find a substance consisting of very small globules. Very few of the cells are furnished with a nucleus (cytoblast) containing a corpuscle. On the other hand, we find in many cells small groups, or simply rings, consisting of these globules. On examining the adjacent older internode, we recognise in a large number of cells, and in the next internode (in which increase in the number and expansion of the cells are simultaneously taking place) in all the cells, perfectly-developed nuclei, which are quite

transparent and provided with their corpuscles. In the transverse section, they appear to be situated in the centre of the cells, whilst in the longitudinal section they are generally seen to be adherent to the wall. They have a flattened form, hence they are detected with difficulty in this aspect. At this period, the granular matter has for the most part disappeared. In the youngest internodes, which have ceased to elongate, and commonly in the next internode also, nuclei still exist in a few of the cells, but they are usually situated upon the lateral walls of the cells. They disappear in the older internodes. 21. During the earliest period of the growth of the stem, neither the production of new cells, nor their expansion, nor the thickening of their walls is dependent upon the presence of the terminal bud, or upon the leaves existing at the end of the articulation.

These excellent investigations might form the basis of the theory of the growth of plants. It is very desirable that similar investigations should be made upon Dicotyledons, the stems of which are subdivided by nodes, and then upon Monocotyledons. The merismatic increase in the number of cells in those plants which the author has examined appears to me proved. There can be no doubt, however, that the septa which are produced must be double; the manner in which they are formed still remains to be determined. In many cases, the growth certainly does not take place according to a geometrical progression; in these an interstitial growth of cells must occur, perhaps in combination with merismatic division.

It is completely decided by all the investigations which have been made, that no formation of cells within cells ever occurs either during the growth, in length or thickness, of vegetable structures, unless we regard merismatic division as such, which would be incorrect. It is by no means my intention to deny the occurrence of this mode of formation in those cases where perfectly new bodies or parts are formed, and the formation of the young plant in the embryo-sac furnishes an instance of the production of cells within cells.

The curvature of stems towards the light will be reported upon in an article in which the general action of light upon plants will be discussed. Dutrochet has made some observations upon the movements of the free points of plants furnished with tendrils, which were spoken of in the previous Annual Report. In the Compt. rend., 1844, ii, 295, there are some observations, by the same author, upon the *Movements of the free Points of twining Plants.* They take place in the same direction as that in which the stem coils itself. Dutrochet connects them with the spiral position of the leaves. In *Solanum Dulcamara* the winding of the stem is sometimes from right to left, sometimes the reverse, and the spiral of the leaves is double. I shall here merely observe on this point, that Mohl has already observed the curvature of both the stem and the tendrils when unsupported. Dutrochet also gives the times in which the turns are completed; but they do not appear to be very constant.

Dutrochet has also made the observation, that in *Epilo bium molle* Lam., (*E. parviflorum* Schreb.) *some of the stems grow* directly *into the earth,* like roots. They are thicker than the upright stems, and are furnished with more cortical substance, which Dutrochet ascribes to their descent into the earth, or rather the thickness of the cortical substance arises from the moisture of the earth. (See Compt. rend., 1845, ii, 1186.)

Boucherie reports, that sections of wood prepared by his method (see Annual Report for 1840, pp. 360, 384), kept sound in the earth for three years, whilst other unprepared sections of the same wood entirely rotted in the same place. Compt. rend., 1845, ii, 1153.

As regards Wydler's *Morphological Communications,* Bot. Zeit., 1844, 641, 657, 688, 705,—I shall merely remark, that they do not permit of condensation into the form of an abstract. The author there assumes, as his basis, an ingenious method of explanation, which was proposed by Al. Braun (Flora, 1842, 694). But other

expressions should be selected, instead of such indistinct and incorrect ones as uni- and bin-axial, because these are very obscure. In these investigations Wydler has especially endeavoured to explain the remarkable structure of the Solanaceæ. It is so marked that the Natural Order is recognised by it, however the same occurs in other Natural Orders and individual genera, for instance, in the Boraginaceæ, *Phytolacca*, and others.

ROOT. TUBERS. PRICKLES. TENDRILS. GLANDS. STOMATA.

On the Tendency of Roots to strike into the Earth (but really into mercury only). By Payer. Compt. rend., 1844, i, 993.—In the year 1829, says the author, Pinot remarked that some seeds of *Lathyrus odoratus*, which he had caused to germinate upon mercury, forced their radicles into it. This penetration was afterwards considered to arise merely from the weight of the seed; others did not observe any penetration; and De Candolle regarded the penetration as arising from the stiffness of the root. Payer then made some experiments upon the point, and found that the radicles of *Polygonum Fagopyrum*, although they are stiff and thick enough, remained on the surface, whilst, on the other hand, the much more delicate roots of *Lepidium sativum* penetrated to a considerable depth. Nor does the weight at all contribute to the effect. If the root be withdrawn from the mercury, it does not again penetrate the metal, but it sometimes shoots further, and then the new portion does so. Light and heat increase its power of penetration. The author thinks that the power possessed by the roots of penetrating the earth arises from their power of avoiding light, and seeking for proper soil. This is explaining something that is unknown by something else which is still more unknown. We have only given an extract from the memoir.

The results, only, of a memoir, by Durand, upon *the*

same subject, occur in the Compt. rend., 1845, i, 861. He first historically adduces Pinot's observation, and adds, that Dutrochet ascribes the phenomenon merely to the pressure of the seed; he then speaks of Mulder's investigations, which were made at the same time, and which prove the contrary. He next details the results of his own experiments. When the seeds are fixed above the surface of the mercury, the roots penetrate; but if this is not done, they do so only when the seeds are placed at the side, between the glass and the mercury, or when a layer of the organic matter is deposited from the water, which fixes the young plant. The seeds of *Polygonum Fagopyrum* do not yield any of this matter to the water, hence the roots do not penetrate.

The *Report of the Commission* upon these two memoirs is given in the Compt. rend., 1845, i, 1257. Several points which in the memoirs are not described, but merely alluded to, are more detailed. The reporter, Dutrochet, finds fault with Payer's memoir, because he has not stated whether he fixed the seeds above the mercury, and if so, how this was done. The following remarks are quoted from Durand's memoir: When the seeds of *Polygonum Fagopyrum* are properly fixed during germination, the radicles always penetrate the mercury. If the seeds are placed in water over mercury, without being fixed, they lose as much in weight as the water which they displace weighs; hence they exert less pressure upon the mercury, and therefore cannot penetrate it. If, under these circumstances, they are but slightly covered, they penetrate to a certain extent. As has been already stated, the semi-solid layer of precipitated organic matters fixes the little plant at the surface of the mercury, and replaces the artificial fixation. As the seeds of buck-wheat do not yield any organic matters to the water, we need only add a little of some extract to the water to produce the same result. Some experiments performed by the reporter (Dutrochet) follow next. He says, "we have used several kinds of seeds in these experiments, and especially those

of *Lathyrus odoratus;* but we have never seen that the radicles of these seeds sank more deeply into the mercury than was caused by the pressure which the weight of the seeds exerted upon the radicles, i. e. not more than three millimeters." The Report concludes with the statement that the phenomenon ensues according to known laws; that M. Durand has discovered that the penetration of the radicles into the mercury depends upon the seeds being fixed, and that when this is not the case, the seeds merely penetrate as deeply as the pressure of the seed causes them to do. The Report censures M. Payer for inaccuracy in the description of his experiments; but this would apply still more strongly to the account which the reporter gives of his own experiments, for he makes no mention of the direction of the radicles which penetrated, and yet this is the main point, if it were really the pressure of the seeds which forced the radicle into the mercury. Moreover it will appear easily explicable that the radicles penetrate the mercury, when the seed is fixed, because this is the only remarkable circumstance, and it is strange enough, when Durand's statement is brought forward. If seeds are placed in water over mercury, without being fixed, they lose as much in weight as the water which they displace; thus they exert less pressure upon the mercury, and cannot, therefore, penetrate; since, by fixing them, the weight is entirely removed, and could not, therefore, cause the roots to penetrate, there is nothing else but the force of the onward growth to make the root descend, and it is remarkable that this is not prevented by mercury. The experiment of Payer is very remarkable; he found that the roots of *Lathyris odoratus* descended through several layers of mercury, in an ingenious apparatus arranged for the purpose. It is also remarkable, that when the radicle is withdrawn from the mercury, the portion which had penetrated will not again do so; but the newly-emitted part does, an experiment which excludes all mechanical explanation. The experiments upon the penetration of the radicles of unattached

seeds germinating upon mercury, do not appear to me of any importance.

A remark which has already been frequently made, is repeated by H. Jaubert, in the Compt. rend., 1845, ii, 360, namely, that on that side of a tree on which the branches are strongest, strong roots also exist. He says that he has very frequently found this to be the case in digging up trees in Sologne. It may be well to recall to mind, since these observations correspond with the view, that the nutritive fluids ascend through the spiral and dotted vessels, and as these vessels do not anastomose, they ascend from the root in a straight direction. That the branches, however, assume curves, like the roots, an instance of which is here afforded, appears to be accidental.

Treviranus has described a remarkable *Formation of Tubers, in Sedum amplexicaule.* D. C. Bot. Zeit., 1845, p. 265.—In this plant, says he, the new shoots which are destined for reproduction are much thickened for about the length of an inch at the summit; the leaves at this part are also closely crowded, whilst at the lower part of the shoot they are scattered. About the period of the summer solstice, not only the main stem, which has flowered, dies, but also the lateral shoots, the thickened points of which constitute the above newly-formed living shoots. On examining the latter, we find, completely incased by the dried sheath-like basis of the leaves, a cylindrical mass of cellular tissue, the cells of which contain granules of starch, and the centre of which is occupied by a small ring of fibres and vessels; at its point is a bud consisting of the rudiments of a few leaves, and which is marked with the scars of fallen leaves. It is a tuber, formed by the confluence of closely-crowded leaves. About the middle of August these tubers emit new leaves; these clothe the next year's stem, which terminates in a flower; they are not, however, sheathing like those which surround the tubers, but semi-cylindrical, like the leaves of *Sedum acre, reflexum*, &c.

PIETRO SAVI on the *Prickles of Amaranthus spinosus.* Giorn. Encicl. Ann., 1, t. i, pp. 17, 310.—The author considers that these prickles are not stipules, as has been thought, but that they are the lowermost, early-developed leaves of an axillary branch. The author's view is perfectly correct; they are situated in the axil of the leaf, low down on the axillary branch, and the main proof consists in their producing tufts of flowers in their axils, which is never the case with stipules. It would be very remarkable were stipules to occur in one species of *Amaranthus* when they are not found in any other, nor in genera related to it.

On the Tendrils of the Cucurbitaceæ. By ATTILIO TASSI. Giorn. Encicl. A. 1, t. i, P. 2, p. 382.—In opposition to the view that they are stipules. His view is principally founded upon the instance of *Sicyos Buderoa* Hook., the alternate leaves of which are furnished on one side below the base with either one, three or six filaments, three or four only of which in the latter case acquire complete development. The author also alludes to the remarks made upon them at the Italian Scientific Congresses. Auguste St. Hilaire (Mémoir. d. Musée, t. ix, p. 192), whom the author does not mention, is the authority for their being considered as stipules. He quotes an instance of *Elaterium,* and a case of abnormal development of *Cucurbita Pepo,* which had produced stipules instead of tendrils. On this point I have remarked, in my 'Elements of Philosophical Botany,' vol. i, pp. 318-9, "But the so-called stipules in the Gourd were furnished at the point with a small tendril; hence the tendril (as is frequently the case with spines) had produced leaves. This minute tendril appears to be absorbed in *Elaterium;* for the true stipules never arise from one side only of a leaf; they are very rarely stalked, and the stalk when present is never round, as the tendril is almost invariably. The tendril, which is now the subject in question, is also situated close to the branch like the spine, and is also a supernumerary branch."

A. St. Hilaire also treats of this point in his 'Morphologie Végétale,' pp. 185-6, and says, in opposition to the view that the tendril occurs on one side of the leaf, that we find on one side of the leaf a developed stipule, and on the other an abortive one (*Ervum monanthos*), and that it is but a small step from this to its complete absence (?). Moreover, in one of the Cucurbitaceæ in the garden at Paris, he had noticed two tendrils. My 'El. Ph. Bot.' were published as early as 1837, the 'Morphologie' in 1841. M. Tassi must extend his inquiries beyond what is done in Italy.

New Researches upon the Structure of Cistomes. By Gugl. Gasparrini. Naples, 1844, 4.—The author has previously described a pouch or sac, which is adherent to the stomata internally. He calls these sacs *cistomi*, because they are attached to the stomata (*stomi*). In the present short communication he now describes a canal which arises from the sacs. His investigations were principally made upon *Cactus Peruvianus*, then upon *Ornithogalum nutans*, and *Arum Italicum*. I have also examined *Cactus Peruvianus*, and have seen the sacs but not the canal, which the author himself has only figured in some, not in all. But the epidermis must be strongly boiled with hydrochloric acid to exhibit the sac; hence it appears to be nothing more than the internal membrane of the aerial reservoir, which the thicker epidermis (cuticle) has entered and lined, as has already been remarked by Mohl. Mohl has also found that the epidermis sometimes extends into the cellular tissue, and there forms, as it were, canals. Too strong treatment with acids materially destroys the connexion of the parts, so that the true structure is no longer recognisable; and this is the case in the present instance. I have not been able to find the canal which the author figures from *Ornithogalum nutans*.

C. Müller has communicated to the 'Bot. Zeit.,' 1845, p. 793, *Some observations on the Resinous Exudations*

of the Birches.—Beneath the epidermis a small heap of cells, filled with green matter, is seen, and which is slightly elevated above the surface; it gradually becomes larger, and lacerates the epidermis. More cells then become superimposed upon each other, and form a capitule, with a more or less thick pedicel formed by the lower cells. The outer cells subsequently become wholly converted into a resinous matter, and are surrounded with a dense brittle mass, the pedicel still remaining unaltered. Finally, the granules escape from the epidermis. The dense brittle mass dissolves in alcohol or ether, forming a mucous mass, leaving no trace of any membrane (which however might very easily be concealed in the mucous mass). The author gives the chemical examination of *betuline;* he considers it to be a kind of *stearoptine.*

LEAVES.

Remarks upon the Arrangement of the Leaves in Dicotyledons. By K. S. KUNTH. Bericht d. Akad. d. Wiss. z. Berlin, October 1843.—The position of the leaves coincides with that of the buds, says the author, and when a bud is about to be formed, a portion of the pith is forced through the woody substance towards the surface of the stem. The spot where this takes place depends upon the arrangement of the woody bundles; thus the first year's shoots of the oak are pentagonal, and the leaves are also arranged in five ranks. On endeavouring to connect the leaves by a line in the shortest course, this can only be done in a spiral direction, and from left to right; moreover the spiral line, to be enabled to reach the nearest leaf, must pass over one of the angles of the wood, to arrive at a leaf which belongs to the same series. Five angles are not always present, still five divisions of the wood may always be assumed to exist when the leaves are arranged in this manner. The author next refers the arrangement of the leaves in the shoots of *Castanea vesca*

in two ranks to the five-ranked, remarking that, when we commence with the posterior single odd rank of leaves, the fourth and third are developed, whilst the first, second, and fifth are not formed. In the same manner he reduces the three-ranked arrangement of the leaves of *Alnus glutinosa* to that in five. From the alternate (*scattered*, says the author, which is, however, the opposite of *fascicled*) leaves he comes to the opposite leaves, which he regards like the former, not, as at the same height, lying in a transverse section made perpendicular to the axis, but merely approximated and alternating. He proceeds in the same manner with the verticillate, or whorled leaves. This valuable contribution to the theory of the arrangement of leaves deserves great attention; and it is certainly of importance to consider the angles of the stem in connexion with the arrangement of the leaves. We must connect with this—

On the Arrangement of the Parts of Flowers. By K. S. Kunth. In the Bericht d. Akad. d. Wissen. Berlin, Feb. 1844.—The whole of the elements of a perfect flower, says the author, form several depressed, equally-divided whorls, and may be connected either by one or two spiral lines which run parallel. Hence we must distinguish uni- and bi-spiral flowers. The organic spirals of Dicotyledonous flowers consist typically of five-membered, bi-spiral whorls; but there are uni-spiral flowers. These usually consist of three whorls; the sepals form the first whorl, the stamens the second, and the pistil the third. These are the only true apetalous flowers, the other apetalous flowers which occur being readily distinguishable by the number and position of the stamens; to these the Thymeleaceæ, Polygonaceæ, &c. belong. The flowers of Monocotyledons are distinguished from those of the bi-spiral Dicotyledons, merely by the three-membered whorl, and thus, like the latter, they also present a calyx and a corolla; hence it is incorrect to ascribe to them a perigone. I shall merely remark here, that this

expression emanates from Ehrhart, and signifies the presence of both calyx and a corolla. The word is well constructed. *P. externum* signifies the calyx, *P. internum* the corolla; hence the expression may be conveniently used where an intermediate form is present, as in many of the Monocotyledons, especially, however, in the Thymeleaceæ, the Polygonaceæ, &c., for the true calyx of a *Chenopodium* is very different in structure from the calyx of the corolla of a *Daphne*.

Disquisition upon a Problem propounded in Phyllotaxy. By ANTON. PRESTRANDREA. Messina, 1843. A. M. Argentano presented for solution, in a journal (Interprete Ann., iv, No. 7), a problem in the theory of the arrangement of leaves, and it is very satisfactory to find that this German theory has travelled as far as Sicily; which would certainly not have been the case, if the excellent report of Martius and Bravais had not appeared in the 'Annales des Sciences Naturelles.' The problem is as follows: In a plant, the arrangement of the leaves of which is spiral, the spiral winds 13 times around the stem, and the angle of divergence amounts to $137\frac{11}{17}$ degrees; to find the number of leaves or foliar organs which compose the cycle. The solution is very simple. If we denote the angle of divergence by d, the number of turns by a, the number of foliar organs in the cycle by m, we have, according to Schimper, $d = \frac{360^\circ . a}{m}$, in which we may denote one of the three magnitudes an unknown x. We then have $137 + \frac{11}{17} = \frac{360^\circ \cdot 13}{x}$, whence $(137 + \frac{11}{17})\, x = 360^\circ \cdot 13$, and therefore $x = 34$. The object is to bring Schimper's theory under consideration (although Al. Braun only is mentioned), in which the divergence of the generating spiral is assumed as $137\frac{11}{17}$ degrees, according to Bravais. The author comments at some length upon the aid which one science can afford another; as an instance

of which this is adduced, and the example here calculated out for beginners.

Schimper's representation of the Arrangement of Leaves is undoubtedly very ingenious, because it collects the vague expressions of the spiral arrangement of leaves into a comprehensive review. The formula given above must be regarded as the fundamental formula, from which the others may be deduced. Its application to opposite and whorled leaves, the leaves of axillary branches, even the development of the leaves in the buds, and the parts of flowers, is no less ingenious. Schimper's explanation is somewhat awkward, and it was therefore very important that Al. Braun detailed this system more accurately, more copiously, and more clearly. An excellent memoir next appeared by MM. L. and A. Bravais, in the 'Ann. des Scienc. Natur.,' 2d sér., t. vii, pp. 42-110. The authors examined the spiral positions of the leaves and foliar parts, the secondary spiral lines, as they are represented on the developed surface of a primary cylinder, where, namely, the spiral lines running from right to left, and those from left to right intersect each other; and point out as the foundation of the whole theory, that when the numbers of the above two rows of spiral lines are respectively primary numbers, there exists a spiral line, which includes all the spots at which the leaves are attached, a generating or including spiral, but if they have a common divisor, verticillate positions occur. In the first case, the angles both of the separate spirals (secondary spirals) and of the individual members in the spirals will coincide with the horizontal line, and the secondary divergences with the divergence of the producing or general spiral. If we call the number of a member in a secondary spiral line n, the divergence of this spiral dn, the divergence of the general spiral $d1$, and m the number of turns made by this spiral before it arrives at n, we then have $nd1 = m \,.\, 360° + dn$. This formula serves for the calculation of the divergence of the general spiral. It is then found, by direct observations,

that this divergence in most cases amounts to 137° 30′ 28″, an irrational angle; in some other and more rare cases, the angle, which is also irrational, is = 99° 30′ 6″, or 77° 57′ 19″, or 151° 8′ 8″. None of these angles are altered, at least their mean values, either by the dissimilarity of the members which follow each other or other local circumstances. The increase is worthy of note, at least according to its average value, especially in Schimper's method of finding the angle of divergence, since we cannot always meet with a foliar part occurring exactly in a vertical line above it. It is remarked also, that for this purpose, the outer rind often requires to be removed in order to distinguish the false from the true angles. The authors also extend their observations to the false whorls, they show that the including generating spiral extends to the underground stem, that the direction of the spiral is the same in the stem and branches, but exerts no influence upon the direction of twining stems. The convergence of two spirals into one, which is sometimes noticed, may arise from the abortion of one spiral or a confluence of two spirals into one, an entire series may then be absent, whence the existence of several series becomes doubtful. It appeared to me important to refer to this memoir again, since it appears to be read less than it deserves, for it not only contains a great many theoretical considerations, but also numerous investigations made upon the plants themselves. Meyen's remarks upon this subject, which have been given in previous Annual Reports, do not appear to me altogether to the point.

In my 'Elem. Philosophiæ Botanicæ,' pp. 450-1, I endeavoured to discover a general expression for the expositions given by Schimper and Braun, by which they might be more easily reviewed. I was unacquainted with the memoir of Bravais; it appeared in 1837, simultaneously with my 'Elementa.' I started from Schimper's theory. Let *m* represent the number of leaves (including in this term bracts also) between two leaves which come next each other in a vertical line, but which are arranged

around the stem in a turns. If we project them in a circle, the distance between two leaves which are nearest one another, is equal to an angle of $\frac{1}{m}$, the apex of which is in the axis of the stem; but if this circle be drawn out a times, the angle becomes $\frac{a}{m}$. This is Schimper's law, according to which, a spiral including all the leaves is taken, and the circumference of the circle is made $= 1$. The line which converges towards or is parallel with the axis of the stem, between two leaves situated in this line, we shall call the principal line, because it is that with which we set out in the investigation. Then to determine the position of any leaf or member in the entire generating spiral, we must ascertain its distance from the principal line. The first member, as we have just shown, is situated at the angle $\frac{a}{m}$, the second at $\frac{2a}{m}$, the third at $\frac{3a}{m}$, and so on, which, deducting each angle from 360° or 1, gives the series $1 - \frac{a}{m}$, $1 - \frac{2a}{m}$, $1 - \frac{3a}{m}$, &c. Thus altogether $\frac{m-a}{m}$, $\frac{m-2a}{m}$, $\frac{m-3a}{m} \dots \frac{m-na}{m} \dots \frac{m-ma}{m}$, with which the series terminates, because there are only m members present. As in this determination of the distance, the entire circumference of the circle is passed through several times, we must leave out these circuits in calculating the numbers, to find the true or least distance. Let $m = 21$, $a = 8$, as Al. Braun found for the cone of the Fir, these numbers, disregarding the signs become

$$13 . 5 . 3 . 10 . 2 . 6 . \ 7 . 1 . 9 . \ 4$$
$$4 . 9 \ 1 . \ 7 . 6 . 2 . 10 . 3 . 5 . 13$$

Thus the numbers recur in the second half, as follows from the form of the series, and when m is an odd number, the mean number is doubled. Where $m = 5$, $a = 2$, which is most common, we have 3 . 1 . 1 . 3, whence it is

at once evident that the angles are twice passed over, if the stem be at all regularly pentagonal and the leaves situated at the angles. When m loses itself in na, the series is at an end even before any of the leaves or members have become included in the spiral, because the quotient then becomes a multiple (in even numbers) of $\frac{1}{m}$, to the fundamental primary angle of the distance of one leaf from another, whence one leaf lies in a straight line above the other, and forms with it the principal line. Twenty-one leaves may be placed in 2 . 4 . 5 . 8 . 10 . 11 . 13 turns of the generating spiral, but not in 3 . 6 . 7 . 9 . 12, because these numbers might yield a product na, in which $m = 21$ loses itself, namely 7 . 3 . 7 . 6 . 3 . 7 . 9 . 7 . 2 . 7. This is not the place for pointing out the application to the secondary spirals, the number and properties of which may be easily deduced from the fundamental series, as has been done in the work quoted above. It appears to me that this series most easily allows of our comprehending all cases of the arrangement of leaves, and I have therefore again brought it forward, and have given some parts fully and distinctly.

Naumann has had his Memoir in Poggendorf's 'Annalen,' upon the Quincunx as the fundamental law of the arrangement of Leaves, printed separately, merely with the correction of the errors of the press. It was spoken of in the last Annual Report.

The Polarity of Buds and Leaves. By MAX. WICHURA. Flora, 1844, p. 161.—Perhaps the author's meaning may be best comprehended from the following passages:—"If, from the point where one bud is situated, we wish to arrive at the place of the next above it, this may always be effected in two different paths. One ascends in a direction to the right, the other to the left. If this be tried with any stem, the buds of which are separated from each other by the divergence ½, it is a matter of perfect indifference whether we take the right

or the left path, for both are of equal length. But whenever the divergence is different from this, one path must be shorter than the other. The next question, then, is—1. Do the buds upon this stem, when they are imagined to be all connected together, either on the longer or the shorter path, follow in the same direction above one another, so that the connecting line presents one continuous spiral, or is this not the case? 2. Which of the two paths unequal in length runs towards the right, and which toward the left? The decision of the former of these questions teaches us, that in addition to numerous plants, in regard to which it must be answered in the affirmative, there are some in which the direction of the spiral is reversed at every point where a bud is attached. Therefore, when we there denominated the connecting line a continuous spiral, we shall here, from analogy with what in geometry is called a fractional degree, apply to it the name of fractional spiral. Examples of this arrangement are afforded by the biserial buds, as in part of the *Papilionaceæ*, in *Tilia*, *Celtis*, *Cercis*, *Ulmus*, *Carpinus*, *Corylus*, *Morus*, *Statice*, *Begonia*, *Phyllanthus*, and many others. I have before me a branch of *Tilia grandifolia*, and find an arrangement of the leaves, not at all uncommon, namely, $\frac{3}{5}$; and according to the fundamental series, the divergences of the individual members are $2 \cdot 1 \cdot 4 \cdot 7 \cdot 10$, thus one small and three great distances, whence the leaves appear almost biserial; but they are by no means really so, for they distinctly lie in a continuous spiral. The author proceeds: "The system of the continuous spiral is, therefore, altogether distinguished from that of the fractional spiral, not only by the direction in which the buds follow one another, but also by the inner structure of the buds themselves. Buds which are developed in the same direction one above the other, surround the stem on two or more sides, are placed under each other in an uniform relation, which frequently degenerates into irregularity. This is the condition of the *indifference* buds. But those

which succeed each other in a continually alternating direction in two series, separated by less than half the circumference of the stem, are symmetrical, and the product of forces uniform, but acting in opposite directions, and this is the state of *polarity*. But all the buds and leaves upon the stem grow upwards, and I cannot see how polarity can act here. It always acts in directly opposite directions, and not at angles. Important as it is to consider an object not individually and separately, but as a whole, there is no *polarity* manifested in this case, unless we change the meaning of the word. The primary phenomenon is ascent in the direction of a spiral, from a verticillate position.

Morphological Communications, by WYDLER; *on the Characterization of Foliaceous Structures external to the Flower*. Bot. Zeit., 1844, p. 625.—Wydler here treats of some of Schimper's definitions of leaves. He divides the leaves on a plant into inferior leaves (*Niederblätter*), frondose leaves (*Laubblätter*), and superior leaves (*Hochblätter*); again, each leaf into a vaginal portion, petiole, and lamina. The frondose leaves consist of—*a*, vaginal leaves, consisting of the vaginal portions only, as in the *Iris; b*, petiolar leaves, consisting of a petiole only, as in the *Acacias, Indigofera juncea*, and *Lathyrus Aphaca; c*, frondose leaves, consisting of vaginal portion and petiole, as in *Allium Cepa; d*, frondose leaves, consisting of petiole and lamina, as in most plants; *e*, laminar leaves, consisting of the lamina only, as in sessile leaves; *f*, frondose leaves, consisting of vaginal portion, petiole, and lamina, as in *Arum*, Palms, *Rheum*, the Umbelliferæ, Leguminosæ, and Rosaceæ. Many of these details are applicable. The name vagina, or sheath, is not inappropriate; and by means of it, we can easily express the distinction between an entire and a half sheath. Instead of the word lamina, which is not German, we have plate, leaf-plate (blade). The leaves of *Iris* do not consist merely of a vagina, but of vagina and leaf-plate. *Allium*

Cepa is also furnished with a leaf-plate, as is seen in young leaves. The subdivision, *e*, shows that the whole section gives but an indefinite and unpractical summary, for the relations of the principal nerves and their distribution is entirely unnoticed.*

In this Gazette, for 1844, i, 134, there are some *Observations upon the Growth of the Organs of Vegetation, considered in a Systematic Point of View*, by A. GRISEBACH. They were made upon *Phlox paniculata, Dianthus plumarius, Saxifraga hypnoides, Peucedanum Alsaticum, Menyanthes trifoliata, Aristolochia Sipho*, and *Ampelopsis hederacea*. To these are added some remarks upon the growth of stipules. As the observations, so to speak, are special, they cannot be reduced into an abstract. There is a supplement at p. 345, which treats of the vegetating points in the sheaths of the leaves. Singularly enough, parent-cells and secondary cells within them are here spoken of, although, at p. 138, the author, from his observations upon *Phlox paniculata*, arrives at the conclusion that in it the longitudinal growth of the lamina is effected by Mohl's cell-division.

Upon the Occurrence of Sugar upon Leaves. By Professor VON SCHLECHTENDAL. Bot. Zeit., 1844, p. 6.—The author especially describes the glands secreting sugar in *Viburnum Tinus;* they exist at the margin of the leaves near the base, one on each side, projecting like a short tooth. When the plant is kept in a room in the winter, a white lump of sugar arises on the surface of these glands. Since the lump of sugar in *Viburnum Tinus*, as also in *Rhododendron Ponticum* and *Clerodendron fragrans*, are only observed in plants living in a room, the author supposes that the saccharine liquid is solidified by the desiccation.

* The reporter gives but an imperfect idea of this paper. The *Niederblätter* or inferior leaves are the bud-scales and analogous structures, the frondose leaves are the general leaves of the stem, the *Hochblätter* or superior leaves, the bracts, &c.—Engl. Ed.

On the Saccharine Glands of Leaves. By UNGER. Flora, 1844, p. 703.—In many Acacias, as *A. longifolia, armata, verticillata*, and *myrtifolia*, the author saw a saccharine fluid drop away; and on careful examination, found at the base of the phyllode, close to the thickening at its upper margin, a small punctiform depression, which is the excretory duct of a slit-like cavity in the substance of the phyllode. This cavity is surrounded by peculiar cells with thin walls, which collectively form a glandular apparatus, in which the saccharine fluid collects, and from which it is gradually evacuated. There are two vascular bundles connected with the saccharine glands, and giving branches to them, the vessels of which are in short joints and curved, and in this manner are lost in the parenchyma of the circumference. The author subjoins some observations, principally relating to the honey-like secretions from the leaves and branches caused by insects.

On the Propagation of Cardamine pratensis L., *by Means of its Leaves.* By JUL. MÜNTER. Bot. Zeit., 1845, p. 537.—The author accurately describes the development of young plants from the leaves of *Cardamine pratensis*, for the most part after Cassini, whose accuracy Schleiden has rendered doubtful. The hemispherical nodule, from which the plants are developed, occurs at the spot where the three principal nerves of the leaflets radiate from each other into the leaf. The roots spring out on the upper side, at first grow upwards, and afterwards, when they have acquired sufficient length, descend. In addition to this, a second bud frequently arises from the middle of the central rib. The most remarkable point is the confirmation of Cassini's observation, that the leaves of *Cardamine pratensis* separate, live under water, and there emit young plants. The author found that the chlorophyll disappeared then, and considers justly that it probably serves for the nutrition of the plant.

M. Pietro Savi has also observed the development of young plants upon the leaves of *Cardamine pratensis* in

the garden at Pisa, and briefly describes them in a note to Meneghini and Savi's 'Memoir upon the Appendages of the Leaflets of Acacia Cornigera,' in the 'Giorn. Enciclop.' i, p. 406. These appendages occur upon the point of the leaflets, but only of the lower ones; they are absent in the upper ones towards the point. They are elliptic-elongate, of one sixth or one eighth part of the length of the leaflet, of a whitish-yellow colour, and are furnished with a central nerve, which is a prolongation of the nerve of the leaf. Around the central nerves spiral vessels occur; the rest consists entirely of cellular tissue. He then treats of the morphological character of this appendage, and of the view that they are probably abortive buds, according to Gaudichaud's theory, in which the leaf is considered as a phyton. Although it cannot be denied that the leaves may be considered as such, when *Cardamine pratensis* is adduced as an example, they must rather be regarded as degenerations of the extremity of the teeth of the leaves themselves, or their entire margin (*come degenerazioni dell' estremita delle dentellature delle foglie stesse e del loro totale*). Were this not the case, they must be considered as glands, which view, however, is opposed by their constant position at the margin of the leaves, and especially at their most prominent points. The appendages are evidently so-called glands, which do not secrete any fluid. Their morphological character, in my opinion, is an indication of a tendency of the leaf to become again pinnate. Perhaps the authors entertain the same opinion.

KIRSCHLEGER has described *the stipules of Platanus.* Flora, 1844, p. 725.—These structures, which have been long known, are merely described by the author, because Endlicher says, when speaking of the Plataneæ, *stipulæ nullæ.* But Endlicher is right; they are not stipules, but *ochreæ,* such as exist in the Polygoneæ, &c. They are not situated at the sides of the petiole, but surround the axis above the base of the petiole.

FLOWERS—FRUCTIFICATION.

Contributions to our Knowledge of the Inflorescence of Cannabis, Humulus, Urtica, and Parietaria, as also of Parnassia palustris, Erodium, and Impatiens. By WYDLER. Flora, 1844, p. 735, 757, 759.—They contain accurate explanations, and form supplements to the memoir in the 'Linnæa,' 1843, which was spoken of in the last annual Report; also remarks upon the ramification of the latter plant. The author's observations upon the arrangement of the leaves of *Polycarpon tetraphyllum*, should be compared with the above. Flora, 1845, p. 33.

Remarks upon the Symmetry of the Corolla. By D. WYDLER; Bot. Zeit., 1844, 609.—The author's morphological investigations are communicated in a very indistinct style. "As we know," says the author, "most symmetrical corollas may be divided by a line into two equal halves, which, starting from the derivative axis of the flower, we imagine to be drawn through the middle of the upper odd sepal and the lower odd petal towards the bract. To this class, amongst others, belong *Pinguicula, Utricularia*, the Labiatæ, &c." But the corolla is a solid figure, which cannot be divided into two equal halves by a line, although it can by a plane. The author means to say that a tranverse section of the flower near its base, a plan of the flower, is divided by a line into two equal halves. This is the manner in which the subject is illustrated by the figures. With a different mode of illustration, numerous conclusions might be drawn, but these cannot be given here.

Morphological Considerations upon Arduina bispinosa. By PIETRO SAVI. Giornal. Encicl., i, 113.

Remarks upon some Microscopic and Superficial Organs of Plants. By PIETRO SAVI. Giornal. bot. Italiano,

i, 27.—The author describes the papillæ and their contents, which exist upon the flowers of *Chrysanthemum indicum*, Thunb.; he considers them as glands. I do not find it mentioned that these papillæ have long since been found and described upon all true corollæ. The blue powder upon the leaves of *Chenopodium* and *Atriplex*, is incorrectly referred to them; it consists of globules of wax.

On merismatic Formation of Cells in the Development of Pollen. By Dr. F. Unger; 1844.—An excellent memoir in a few pages. "According to my observations," says the author, "the earliest traces of renewed organization in the mature parent-cells, appear as very thin and delicate streaks, which either run transversely across the centre, or laterally, according to the position of the parent-cell. These streaks, as any one may easily satisfy himself by turning round the parent-cell, are nothing else than extremely thin and transparent walls, which divided the uniform granular matter into several parts. These walls, which must necessarily be formed from the above-mentioned contents, are so perishable, that they dissolve in water, which renders it probable that they consist of gum. But simultaneously with this phenomenon, a spontaneous separation of the granular mucilage occurs, which especially tends to show that from this moment the nucleus of a cell begins to be developed in each portion. The formation of these walls still proceeds, so that they not only soon acquire greater firmness, but also greater thickness. The first commencement of true membranous development (for the earlier deposit can scarcely be considered such) distinctly takes place from the walls towards the central point. First, there appear projecting ridges, and from these the membranes crystallize, as it were, more and more toward the interior, so that we can trace the progress step by step." Further on: "Hence there are no special parent-cells, separate and inclosed by the parent-cells, but only special parent-cells which originate as divisions of

the parent-cell, and only undergo partial separation in the highest stage of their development." Hence the result is that, even in pollen, the formation of cells from a cell-nucleus never occurs.

In the 'Flora,' 1844, p. 359, FACCHINI communicated the *Investigations of* AMICI *of Florence, upon the impregnation of the Embryo*—which are opposed to Schleiden's theory of the development of the embryo. Schleiden did not omit at once answering them, l. c. 787. Facchini therefore gave the *Italian text of Amici's memoir*, as it exists in the Transactions of the 'Scienzati' of Padua, with the remark, that all present were convinced by Amici. Schleiden, l. c., 593, then accuses all who were present of gross ignorance, and abuses Amici's figures in his peculiar style. Any one who wishes to know how Amici, the discoverer of the pollen-tube, is treated, may read this paper. We gladly turn from this subject to a remarkable work—

Experiments and Observations upon the Organs of Fructification of the more Perfect Plants. By C. FR. GARTNER, Stuttgard, 1844-8.—We have here such an abundance of experiments and observations made with great calmness and circumspection, that we may assert with truth, that no modern work has contributed so much to the physiology of plants as the present. This is not the place for carefully going through the whole, we can only enter generally upon it, and notice a few of the various points on which it treats. Moreover, in addition to the new and peculiar results which it contains, we have in every case a notice of the opinions of others, which are contradicted or confirmed by reasoning and experiment. 1. On the Flower. Cause of the abortion and falling off of the flower. 2. Of the Calyx. If the impregnation of the ovary has not been effected, the calyx *decays*, and assumes a diseased appearance; it remains in this state for several days, according to the species of the plant. 3. On the

Corolla. Castration has no effect upon the corolla, and the presence of the stamens is not in the least necessary for the preservation of its integrity and perfect development. The styles are generally developed subsequently to the corolla, in a few plants only does the reverse occur, as in *Lychnis diurna*, *vespertina*, *Dianthus barbatus* and *superbus*. When in the latter case the stigmas are sprinkled with the pollen of the same plant, whilst the flower is but little or only half developed, the growth of the latter is checked, or entirely ceases. Many observations and experiments are made upon the diurnal sleep of plants; impregnation exerts great influence upon it. 4. Upon the secretion of honey (nectar) in flower. Tending rather to contradict the views which have been asserted, than to propose definite laws. 5. Upon the stamens of plants. The observation is remarkable, that hybridation gives a tendency to wasting of the anthers. The duration of the power of the pollen is very different in different plants, and also very different from the duration of the susceptibility of the female organ to impregnation. The author's remarks upon the pollen-tubes, and their penetration into the micropyle, do not bear the least relation to the rest. 6. On the evolution of heat from flowers. Many original observations. It occurs also in the female organs, and is often connected with the odour. 7. On the pistil. 8. On the phenomena of irritability and motion in the flowers and organs of fructification of plants. A number of observations and experiments, especially upon the irritability of the pistil in *Mimulus*. Development of the same. When cut off and kept in moist sand, they exhibited the same phenomena as when *in sitû*, the destruction of the one stigma exerts no particular influence, concussion produces no effect upon them. Experiments with chemical irritants. Among these there are also experiments with oil of morphia (a mixture of morphia and poppy-oil), which prove, that the irritability and capability of movement of the pistil of *Mimulus* is diminished and finally destroyed by it. This is also the case with Strychnine

oil. Castration has no further influence upon the irritability, than that it lengthens the period of duration of the flower, and thus of the pistil also. Experiment upon the action of the pollen of the same flower; this is only exerted during the time of the susceptibility to impregnation, but chemical irritants act at other times. In many flowers, movement occurs during the period of impregnation, without irritability; observations upon the deportment of the flowers of *Tropæolum majus*, &c. Observations upon *Stylidium*. 9. On the impregnation of perfect plants. The dehiscence of the anthers in many plants occurs uniformly before the flowers open, but in most, afterwards. Action of light, heat, and moisture. The author never succeeded in obtaining ripe seeds from branches of dicotyledonous plants which were cut off and kept in water. Other promoters of impregnation. Forty grains of pollen were required to produce impregnation in *Malva Mauritiana*. Similar experiments upon *Tropæolum majus*. Precautionary rules and phenomena of artificial impregnation. The nucleus is capable of continuing its growth for some time without impregnation, but it does not produce an embryo. Phenomena observed after fructification in the nucleus and the seeds of twelve flowers of *Lychnis vespertina*. Similar observations upon *Staphylæa pinnata*, during a period of four months; in both cases with accurate anatomical investigations, but without figures. He arranges my observations upon *Angraecum* with his own upon the embryo of *Corydalis*, but he is still unacquainted with the figures in my Anatomico-Botanical Plates, which would have taught him the great difference between them. 10. Upon the abortion of flowers, fruits, and seeds. Shorter than the other memoirs. 11. Upon the production of fruits, with seeds capable of germination, without the application of pollen. The observations of others upon the subject are criticised, and their insufficiency pointed out. His own observations yielded a perfectly negative result. 12. On the impregnating power of plants. 13. On false impregnation.

The author follows Kolreuter in applying this term (afterbefruchtung) to abortive impregnation, produced by the pollen of the same plant. 14. On the effect of sprinkling the stigma with foreign matters. Experiments of the author in opposition to Henschel's now forgotten experiments. We anxiously look forward for the second part.

A Paper, by RÖPER, *on the Flora of Mecklenburg*, 2 pt. Rostock; contains *Researches upon the Flowers of the Grasses*, which we recommend all botanists to read. It is especially opposed to Schleiden's theory, viz., that the lower and outer valve of the glume, or the palea inferior, forms a trifoliar perianth with the upper and inner valve of the glume, which originally consists of two valves. It distinctly shows how Schleiden's censoriousness misleads him into the greatest inconsistencies. It also contains several other investigations of importance. As on most points I agree with the author, it would be superfluous to make any remarks. Nor is this the place for explaining the true condition of the flower of *Lolium temulentum* (*Cræpalia*, Schrank), regarding which the author appears to be mistaken. One observation more. The author sets philology at defiance, and adopts such expressions as *sepalum*, *tepalum*, &c. Language is so remarkable and wonderful a production of the human mind, that it must not be trifled with; an unfortunate proceeding, which has in recent times been especially revived by De Candolle.

On the Signification of the Lower Glume of the Flower of Grasses. By HUGO VON MOHL. Bot. Zeit., 1845, p. 33.—The author also shows by an analysis of the common monstrosity found in *Poa Alpina*, that the lower floral glume is not to be regarded as a perigonial leaf, but as a bract.

Note upon the Organography of the Flower of the Malvaceæ. By M. DUCHARTRE. Compt. rend., 1844, i,

p. 487; 1845, i, p. 349. Report, ibid. ii, p. 417, and in detail, in the Ann. de Scienc. Natur., 3 sér., t. iii, p. 123. Report, p. 150.—The external calyx (involucre), is first formed, then the true calyx, from a single piece. A globule next arises in this, which exhibits five tubercles; this soon subdivides into two parts, and thus the flower, even in its youngest condition, is furnished with ten staminal tubercles. Five small folds next appear close to the calyx; these are at a tolerable distance apart, and constitute the commencement of the petals. Hence the flower is at first pentapetalous. The development of the stamens, internally, next follows, according to a double plan, first by concentric circles, which grow inwards, and then by the deduplication of the stamens. They are really situated opposite the petals, but in many Malvaceæ, we find that the filaments become elongated above the stamens, and form five teeth, which alternate with the five groups of the andræcium, and thus represent the inner row of stamens. The formation of the pistil varies, and the author admits four different methods by which it takes place. To this subject belong:

Observations upon the Organogeny of the Flower, and of the Ovary in particular, of Plants having a free central Placenta. By M. A. DUCHARTRE. Comptes rendus, 1844, i, p. 1105.—Development of the flowers of the Primulaceæ. The calyx is first formed in one piece, not several, as Schleiden states. Five tubercles next appear, from which the stamens are formed; the appearance of the corolla seems to precede that of the stamens, when they alternate with the segments of the corolla; otherwise, it follows after. The pistil appears simultaneously with the corolla in the form of a cone, and the placental tubercle fills up the ovary. The ovary next rises up and forms the style. The summit of the placenta subsequently begins to elongate, and passes into the canal of the style, and is not, therefore, at first connected with the stigma. The report upon this memoir, by Ad. Brogniart, Ach. Richard, and Gaudichaud, is, on the whole, favorable.

The Observations of GELEZNOFF *upon the Development of the Flower of Tradescantia Virginica.* Bullet. de la Société Impér. des Naturalistes à Moscou, vol. xvi, 1843; Flora, 1844, p. 144; Bot. Zeit., 1844, p. 183, should be compared with the above.

The Academy of Naples has given an account of the *Memoirs* which it has received *in reply to its Programme upon Caprification.* The Memoir No. 1 denies its influence in fertilization. Female flowers are always found in the fruit, but no males; and the impregnation of the figs remains a mystery. The author does not recommend caprification. The Memoir No. 3 arrives at the following conclusions: 1. The wild fig is not the male of the cultivated fig, as it has been considered. 2. Inasmuch as the structure of the flower and the seeds in the varieties of the cultivated fig are exactly the same, there appears no reason why caprification should be requisite in some varieties and not in others. 3. The insect does not hasten the ripening, neither does it contribute to the setting of the fruit any more than it does to its impregnation. 4. The falling off of the fruit of the wild fig, which contains no larvæ, proves nothing, for when many fruits have set upon the tree, they still fall off, even when larvæ are present. 5. The cause of the falling off must be sought in other circumstances; in the climate, changes of the weather, &c. 6. Caprification is perfectly useless, either for ripening or setting the fruits. The Memoir No. 5 contains the conclusion: That the action of the Cynips upon the cultivated fig is entirely mechanical, and merely serves, like any other irritant, to accelerate somewhat the ripening of the fruit. Hence, when this is not requisite, caprification is perfectly useless, nay, even injurious to the perfect maturation of the fruit. The Memoir No. 6 considers caprification requisite, but only in the case of the abortive figs. One memoir only, to which, however, we shall only briefly allude, considers that it is necessary for fructification. In my early days

I had an opportunity of observing caprification in Portugal, and in the account of my travels I have stated that caprification exerts no influence upon impregnation. However, many varieties become larger and more beautiful when they are pierced by this minute Cynips, as is very truly stated in the Memoir No. 5.

In the 'Thuringian Horticultural Gazette,' Nos. 1 and 2, Prof. Bernhardi treats of *Bastard Forms*. He now considers that the so-called bastard forms of the genus *Gymnogramma* (*Ceropteris*) might arise, not from impregnation, but from the coalescence of the roots with each other, because they germinate in hot-houses in numbers together. As an instance, he mentions a plant of *Cytisus Adami*, which was produced by grafting *C. purpureus* upon *C. alpinus*, whereby a hybrid was produced, which frequently assumed the characters of a bastard, and often returned to its primitive conditions, at one time producing purple, at another yellow flowers. This is remarkable enough, and is the first instance of the formation of bastards in this manner.

FRUIT. SEEDS. GERMINATION.

Memoir upon the Development and Characters of true and false Arils. By J. E. Planchon. Montpellier, 1844. —An excellent contribution to our knowledge of the changes undergone by the seeds in their young state. First, a history of the meaning of the word aril. Then an investigation of the nucleus in *Passiflora*. Since, in this instance, an expansion of the umbilical cord is not formed until after impregnation, as it is only connected with the seed by means of the external umbilical aperture (hilum), and at the opposite end is widely open, since, therefore, this structure agrees with the generally admitted notion of the word aril, the author denominates it a true aril. The aril of *Euonymus latifolius* is very different, although it agrees with the former in many particulars.

After the fall of the petals and stamens, the nucleus grows somewhat: a protuberance is then formed at the margin of the exostome, which grows out, expands into a membranous margin, and extending towards the base of the nucleus, forms a hemispherical cover, which covers the base of the nucleus, but leaves the micropyle completely uncovered, whilst, on the other hand, the true aril covers the micropyle. The author calls the aril of *Euonymus* a false aril or arillode. The definitions then of these parts are: the true aril is an accessory covering of the nucleus, which is developed around the umbilical aperture (hilum), in the same manner as the proper coverings, and either covers the exostome, or would do so if it were sufficiently developed. The false aril or arillode is an expansion of the margins of the exostome, which is reflected around this aperture, but always leaves it uncovered. We have examples of true arils in the Dilleniaceæ, the Samydaceæ, the Bixineæ, *Nymphæa cærulea* and *alba*, but it is absent in *Nuphar lutea*. Moreover, *Chamissoa* is mentioned as an example, and a description is then given of the seed of *Cytinus Hypocistis*. The ovary of this plant is filled with a mucus, and upon its walls there are ramified but compactly superimposed placentæ. I shall give the description of the ovule and seeds in his own words: "*Ovula orthotropa, creberrima, minutissima, occidua, utrinque attenuata, basi arillata. Integ. unicum, vasculis destitutum, arcte adhærens, membranaceum, pellucidum, apice perforatum. Nucleus solidus, cellulosus, ovulo conformis, subdiaphanus. Arillus irregulariter cupuliformis, brevis, crassus, margine inæqualis e cellulis laxis latis constans, vix quartam ovuli partem inferiorem obtegens, ab eodem facillime secedens. Semina (in fructu siccato) ovulis conformia, pallide lutea, mucilagine in lacrymas solidas, vitreas coagulata involuta. Arillus et integumentum ut in ovulo, prior non raro obliteratus. Nucleus solidus, omnino cellulosus. Embryo nullus.*" The author in fact thinks, that no embryo is present, because as the ovule is orthotropous, impregnation could only occur through the mucus of the

ovary. But may not the entire nucleus be an embryo? He includes amongst false arils the remarkable envelope of the seed in *Opuntia*, the formation of which is here shown to occur from two lateral expansions of the funiculus. Moreover, the false aril of *Euonymus latifolius*, which has been already mentioned, belongs here; the tubercle in the Euphorbiaceæ also is only the thickened margin of the exostome, and the aril, as it is called, of the Polygalaceæ agrees in many points with it. In *Clusia flava* we must assume, that the outer envelope of the nucleus, which is simple in the greater part of its extent, becomes doubled, divided into two unequal prolongations beyond the exostome. It is doubtful whether the Nutmeg does not belong here. The author denominates by the term Strophiola the glandular excrescences situated along the raphe; they are independent of the umbilical cord and the exostome, and he mentions, as an example, the seeds of *Arum Canadense*. Finally, the history of the nucleus of some species of *Veronica*, especially *V. hederæfolia* and *V. Cymbaria*, with remarks upon the genus *Avicennia*. The peculiar operculum of the seed of the latter originates from the embryo-sac, which in *Veronica* is converted into albumen. The embryo-sac of *Avicennia* ruptures the nucleus in the ovary, and the embryo also ruptures the embryo-sac by too rapid germination in the fruit. In *Veronica hederæfolia*, the nucleus at an early age is reduced to the embryo-sac only, and has no covering. The details must be obtained by the examination of the author's work itself.

In a memoir which M. Guglielmi Gasparrini read before the Academy of Naples as early as 1842, he endeavoured to show, that the fruit of the *Opuntia* is merely a branch adapted for this purpose. The nuclei are at first situated in the central cavity in rows, the wall of the cavity is not a distinct organ, like the ovary in other plants, but consists of a special complicated fibrous tissue, which is produced for this structure. This fibrous tissue is both

podospermous and trophospermous. The free podosperm, although very short, is the primary membrane of the ovule; after impregnation they become covered with cells (otricelli), which arise from the growth of the surrounding cellular tissue, and constitute the pulp, by means of which the seeds become separated from one another, and are lost in the pulp. The pulpy mass containing the seeds is not connected to the receptacle or to the summit of the flowering branch, but to the upper part of the bark, where the petals, stamens, and the outer styles arise, by means of a fibrous tissue which descends so as to terminate in the seeds. This subject deserves more minute examination, not only in regard to the adhesion of the style to the ovary, but especially with regard to Planchon's investigations, which appear to form a supplement to those of Gasparrini.

Note upon the Embryogeny of Taxus baccata. By MM. DE MIRBEL and SPACH. Compt. rend., 1844, i, p. 114.—In addition to the embryo which is developed, the authors found two vesicles; they do not consider these as abortive embryos, for long before the embryo appears, these vesicles become adherent by their base to the apex of the embryo-sac, and the tube (*boyau*), which is above each of them, becomes elongated by means of the nucleus almost as far as the surface of the upper end. Hence the authors consider that they serve in impregnation.

Investigations upon some Vegetable Monstrosities, which may serve to illustrate the origin of the Pistil and of the Nucleus. By AD. BROGNIART. Compt. rend., 1844, i, p. 513.—It is a question whether the seeds arise from the axis, or from the margins of the carpellary leaves. "The example which it is my intention to make known," says the author, "exhibits in its carpels all the stages of the formation of the leaf; it exhibits at its margin ovules, some of which scarcely differ from the normal ovule; others form imperceptible transitions to lateral lobes of the carpellary leaf. It is taken from a plant of *Delphi-*

nium elatum, which flowered in 1841 in the Garden at Paris.

On the Development of the Ovary, the Embryo, and the anomalous Corollas of the Ranunculaceæ. By BARNEOUD. Compt. rend., 1845, ii, 352.—As the rows of stamens become doubled, we find at their base two oval, somewhat approximated plates, which alternate with the sepals; and a little more internally, in a different plane, we find five other ovate plates, which are smaller than the former, and opposite the segments of the calyx. This shows that the two spur-shaped petals belong to another and larger whorl, the other elements of which abort regularly; the next whorl also aborts. The ovule is always anatropous, but exhibits three remarkable types. According to the first, it makes half a rotation upon itself, in an horizontal direction, and the exostome is directed towards that side on which the placenta is situated, as in the Helleboreæ, Pœonieæ—transverse anatropy. In the second type, the ovule rotates vertically, and the margin of the exostome is turned towards the base of the carpel—inferior anatropy, as in the Ranunculeæ. According to the third, the ovule is suspended, and the exostome turned towards the summit of the cavity—superior anatropy, as in the Clematideæ and Anemoneæ. The embryo-sac exists previously to impregnation; it becomes filled with cells, which are subsequently transformed into the albumen.

Chemical Researches upon the Ripening of Fruit. Compt. rend., 1844, 784.—This subject is a most important one, and as the chemical changes which occur during the ripening of fruits are very distinct, perhaps one not very difficult of attainment. But isolated remarks against this and that point, such as we find here, are of no use. The experiments must first be performed upon one fruit only, and cherries would be best for this purpose, because they quickly ripen, and undergo great changes during maturation; moreover, as it appears to me, their analysis would be easier than that of the pear, &c.

Germination of Chærophyllum Bulbosum. By Professor KIRSCHLEGER. Flora, 1845, 401.—The seeds had germinated in spring, with two cotyledons; however, no bud existed between the cotyledons; but at the base of the plumule a tuber was developed, which, during the same year, bore radical leaves, and in the following year flowers and fruit. This circumstance was not unknown, having been long since observed in *Bunium bulbocastanum.*

An account of some Seeds buried in a Sandpit, which germinated. By WILLIAM KEMP. Annals of Nat. Hist. v, 13, p. 89.—The layer of sand which contained the seeds was nearly 25 feet (see Ann. Nat. Hist.) below the surface. They germinated, and were found to be those of *Polygonum Convolvulus*, and a variety of *Atriplex patula*, with *Rumex acetosella*, an *Atriplex*, &c., only common British plants. The author considers them to be of an immense age, and supposes that the Tweed had flowed through the valley, and deposited the seeds, before a large vein of trap-rock passed through it. Probably a more accurate examination would somewhat diminish the time.

Wahlberg's remarks in the Report of the Swedish Academy are more reasonable. (Vide Flora, 1845, p. 61.) He sowed the seeds of several plants, foreign and Swedish. The place was covered with building materials for many years, and when these were removed and the soil dug up, several plants sprung up which had previously flowered there.

Periods of flowering and ripening of several wild and cultivated plants, which were observed in 1843, for the purpose of forming a scale of the development of plants in various parts of the duchy of Nassau, in the Annual Reports of the Society for the promotion of Natural Science in the Duchy of Nassau, by Dr. K. THOMÆ. Wiesbaden, 1844.—The plants were: *Ribes rubrum* and *Grossularia*, *Fragaria vesca*, *Rosa canina*, *Primula veris et officinalis*, *Sambucus nigra*, *Prunus*

spinosa, domestica, avium, Pyrus malus, Secale cereale, Triticum vulgare, Hordeum vulgare, Avena sativa, Solanum tuberosum, Vitis vinifera, Juglans regia, and *Castanea vesca.*

INDIVIDUAL ORDERS AND GENERA OF THE PHANEROGAMIA IN REFERENCE TO PHYSIOLOGY.

Description of the Female Flower and Fruit of Rafflesia Arnoldi, with Remarks on its Affinities, and an Illustration of the Structure of Hydnora Africana. By R. BROWN. Transact. of the Linn. Soc., vol. xix, pt. 3 (1844) p. 221. —The author, with his usual accuracy and well-known acuteness, investigated the above objects, and treats of them with a certain heartiness which renders the subject very attractive. The whole is illustrated by the excellent drawings of Ferdinand Bauer. The ovarium of *Hydnora* may be regarded as composed of three confluent pistilla, having placentæ really parietal, but only produced at the top of the cavity. It would, however, certainly be difficult to reduce *Rafflesia* to this type. The author then describes the development of the ovules of *Rafflesia* in their earliest state, which agrees with that occurring in Phaneragamous plants generally, the lower portion of the papilla becoming dilated, forming a cup, and enveloping the future integument and the nucleus. Thus the author's description differs, and rightly, from that of Mirbel's. According to the author, a curvature occurs, as in several Phanerogamia, but only in the upper part of the funiculus, whereas in the Phanerogamia generally, the curvature is produced in that portion of the funiculus, which is connate with the testa. The reason of this may be, says R. Brown, that the testa is absent in the seeds of *Rafflesia*. The author only found pollen-tubes in *Cytinus*. The testa of the seed of *Rafflesia* is evidently the same which exists in the unimpregnated ovule, and is very hard; the inner membrane is thin; the nucleus appears to be entirely composed of cellular tissue, but in

the middle of it a cylindrical portion is found, which consists of large transparent cells, which the author regards as the embryo. The seed of *Hydnora* resembles that of *Rafflesia* in many points. Its nucleus consists of a dense albumen, in which a spherical embryo is found. In *Cytinus* the seeds are minute, and retain at their base the bipartite membrane, which may with most probability be considered as a prolongation of the testa. The latter is easily separable from the nucleus, which appears to consist of an uniform cellular mass, as in the Orchidaceæ. He finally asserts that vascular tissue is not absent in the Rafflesia and Balanophoreæ, and adds, that frequently, plants which are very different in external aspect, are of the same internal structure; I might add, as in Cycadeæ and Coniferæ. Lastly, he gives a botanical description of the female flowers and fruit of *Rafflesia Arnoldi* and *Hydnora Africana*.

On Macrozamia Preissii. By G. HEINZEL. Nov. Act. Acad. Leop., vol. xxi, pt. i, p. 203.—This forms an inaugural dissertation, which appeared at Breslau, and well deserves to be received into this work. The description of the plant is very good, and great attention is paid to the physiology. The stem and leaves are not treated of, although these are of great importance, but only the male and female organs of generation. It is a very remarkable circumstance, that the hard unilocular anthers are irregularly produced from the scale in most species. The author describes very accurately a minute pedicle upon which the anther is formed; I have detected it in other Cycadeæ, and always find it to contain a vascular bundle. The author then advances an adventurous morphology, according to which the scales merely consist of convoluted stamens (*filaments*). These strained hypotheses should not be had recourse to in matters relating to the vegetable kingdom, and no morphology at all is far better than a forced one. With regard to the ovule, he does not follow R. Brown, but thinks that what

he considers to be an exostome is rather a stigma. A detailed *Criticism* of this paper, by Dr. Gottsche, of Altona, is given in the Bot. Zeitung., 1845, pp. 366, 377, 398, 413, 433, 447, and 507, which contains much remarkable matter, and therefore deserves great attention. Thus it contains a minute examination of the ovule of *Encephalartos longifolius*, with comparative observations upon other Cycadeæ and Coniferæ. We cannot follow the author in his investigations, for this would require a separate memoir.

Upon the Structure of a full-grown Stem of Cycas circinalis. By F. A. W. Miquel. Linnæa, 1844, p. 125, tab. 4, v, 6.—A good description of a full-grown living stem, of which we were not before in possession. The internal structure is especially remarkable; it consists of a cortical parenchyma, which is composed of three layers of cells. The wood is divided into concentric, unequal and irregular layers, which are separated from each other by thicker or thinner layers of parenchymatous cells, containing starch. Each woody layer is divided into almost quadrangular or club-shaped woody portions by distinct medullary rays. On examining the large woody layers, we find that they take a very serpentine course. Those vessels which assume a lateral direction, perforate the bark, and run to the scales and leaves. All the vessels of the wood are dotted. Some of the roots were cut off, but they entirely agreed in structure with the stem. In my 'Icon. Sel. Anat. Bot.,' vol. ii, I have already shown the difference between the structure of Dicotyledons and the Cycadeæ; the vessels do not ascend directly upwards, as in the Dicotyledons, and they traverse all parts of the bark towards the leaves and scales, which is only the case in Dicotyledons at individual buds. More recently I have endeavoured to show, in a short memoir read before the Academy of Sciences, that the scales are in fact leaves, and that the so-called leaves are branches. This renders the germination, especially, very intelligible.

The tap-root, which otherwise is absent in all Monocotyledons, is particularly remarkable.

Observationes de Ovulo et Embryonibus Cycadearum. Auct. T. A. Guil. Miquel. Ann. d. Sc. nat. 3 sér. vol. iii, p. 193.—The following periods of the development of the ovule appear to be distinguishable: 1. Before impregnation, the cellular tissue of the nucleus beneath the amnios becomes completely absorbed, and leaves a cavity upon which the amnios lies. On the other hand, the cavity of the amnios becomes gradually filled with cellular tissue beginning at the base. 2. This cavity of the nucleus, which is filled with mucus, then forms a cellular mass, which does not become connected with the walls of the cavity, but is inclosed by a membrane; this is connected with the membrane of the amnios and forms the albumen. The formation of the albumen does not depend upon impregnation, for it occurs even in sterile seeds. The formation of the narrower cavities in the amnios does not appear to be dependent upon impregnation. 3. Whilst the peculiar cavities are being formed in the amnios, and the embryoblastanon (of Hartig) is growing downwards, the entire amnios, excepting its external membrane, descends into the hollowed apex of the albumen which is in progress of formation, and is inclosed by it, and the apex of the albumen is covered by the outer open apex of the amnios, as with a cap. 4. The cellular tissue of the amnios now becomes absorbed, soft; the sacs traversing the mucus remain and are covered by a soft membrane with which they become coherent. 5. As the embryo enlarges, the embryoblastanon which is reflected upwards becomes compressed, the mucous matter surrounding the sacs dries, and the membrane covering it disappears, so that when the seeds are ripe, the embryoblastanon, with the sacs, are found in the form of an amorphous mass, under the persistent membrane of the amnios, at the point of the root which is forming. The author then speaks of the anthers of the Cycadeæ, and states

that they contain *cellulæ fibrosæ* like other anthers. Lastly, he characterises the genera *Cycas, Macrozamia, Encephalartos*, and *Zamia*, by the form of the embryo. In an appendix, vol. iv, p. 79, the formation of the albumen prior to impregnation is confirmed.

On the Plurality and Development of the Embryo in the Seeds of Coniferæ. By ROBERT BROWN. Annals of Natur. History, vol. xiii, p. 369.—This paper was read before the British Association at Edinburgh in 1834; it was published in French in the 'Annal. d. Scienc. Natur.' for October 1843, and then appeared in the above journal. After alluding to his former views upon the plurality of the embryos in the Cycadeæ, which indicates their affinity with the Coniferæ, the author then reports upon his observations on the seeds of *Pinus sylvestris*. "The first and most important change," says he, "is the production or separation of a distinct body within the nucleus of the ovule, which before impregnation is a solid uniform substance. In this stage, the included body or amnios is slightly concave, and covered with a lacerated cellular tissue, which either arises from its separation from the apex of the original nucleus, or of a process which connects it to the apex. Below the concave apex, the amnios is slightly transparent for about one fourth of its length, the remaining portion being perfectly opaque; it consists of cellular tissue. Before the appearance of the embryos or the funiculi, the areolæ in which they are produced are visible. These areolæ, three or five in number, as observed in May 1827 in the larch, are arranged in a circular or elliptical series, near the apex, with which they probably communicate by some points which it is difficult to distinguish. In *Pinus sylvestris*, they were considerably more developed in June or July, from four to six in number, consisted of conical membranes of a brown colour, with their apices turned towards the surface, and at the base seeming to pass gradually into the lighter-coloured pulpy mass of the amnios. Corresponding and nearly

approximated to each of these conical membranes, a long funiculus was found; this was either simple or giving off a few branches, and generally consisted of four series of long transparent cells. The upper extremity of each funiculus was considerably thicker, of a depressed spherical form, and each cell contained one of the granules (areolæ), as is frequently observable in the Monocotyledons. In *Pinus pinaster*, the funiculus has no appearance of subdivision, but this finally appears at its ends. By tracing their development until it is completed, we see that each of the dark bodies, in which the funiculi terminate, are embryos in a rudimentary state. Hence the author concludes, that the plurality of the embryos in the order Coniferæ is perfectly constant. In a postscript in 1844, R. Brown shows, that he had already given the plurality of the embryos in the Cycadeæ in his 'Prodromus Flor. N. Holland.,' but that Dupetit-Thouars had discovered the principal fact. He then alludes to Schleiden's theory, and says: "Schleiden ascertained the existence of my areolæ or corpuscles, and denominates them large cells in the embryo-sac or albumen; he states, that he has succeeded in preparing free the whole pollen-tubes from the nucleary papillæ to the bottom of the corpuscles. But if my observations are correct," adds Brown, "and they appear to be confirmed by those of Mirbel, the corpuscles in *Pinus* are not developed until the following spring or summer, and hence if Dr. Schleiden's assertion is correct, the pollen must remain inactive for at least twelve months. This is not altogether improbable," says Brown, "but even if it were the case, it would not lead to the adoption of Schleiden's theory. With respect to the Cycadeæ, adds Brown, under any circumstances it is certain that the mere enlargement of the fruit, the consolidation of the albumen, and the complete formation of the corpuscles in its apex, are wholly independent of male influence; for he had seen instances of this in England, when the male plants of the female Cycadeæ which were examined did not exist in the country.

On the Apocyneæ. By ALPHONSE DE CANDOLLE. Ann. d. Scienc. natür., 3 sér. vol. i, p. 253.—This paper is referred to here, on account of the investigations which it contains upon the stipules of this plant.

Mémoire sur la Famille des Primulacées. By M. J. E. DUBY. Geneva, 1844.—Germination of the seeds of *Cyclamen,* where the large tuber is directly formed, and the cotyledons are not developed.

Researches upon the Development and the Structure of the Plantagineæ and Plumbagineæ. By M. F. M. BARNÉOUD. Compt. rend. 1844, ii, p. 262.—I. *Plantagineæ.* When the flowers are examined in their earliest state, the development is found to occur from without inwards, in opposition to Schleiden's theory. The flowers at first consist of four tubercles, which have exactly the form and structure of the anthers; each also is furnished with a bundle of spiral vessels, and they unite into a tube. Hence the flower is a tube which supports the stamens, as in the *Gomphreneæ* and *Achyrantheæ.* The margins of the valves of the ovary are at first some distance apart from each other, and continue to approximate, but never come completely into contact, hence there are no axile bodies in the ovary of this order.

II. *Plumbagineæ.*—The symmetry in this tribe appears to be anomalous, because there is one row of stamens which are opposite the petals. But the author has discovered the rudiments of stamens in *Plumbago micrantha;* they, however, soon disappear, so that the row of large stamens then forms the rule.

Observations upon the Genus Aponogeton and upon its Natural Affinities. By J. E. PLANCHON. Ann. d. Scienc. natur., 3 ser., vol. i, 107. Also Compt. rend., 1844, ii, 227.—The author correctly separates this genus from the Saurureæ, and approximates it to the Alismaceæ. The germination is very accurately described here. A single

cotyledon with two rudimentary radicles, and a plumule issuing from a fissure, the leaves not being sheathing. But the figures themselves must be referred to.

On the Anatomy of Aldrovanda vesiculosa. By Professor Parlatore. Giorn. Enciclop, i, 237. Compt. rend. 1844, i, 998.—A minute description of this plant, which is known by its vesicles (*ampullæ*), which are in fact leaf-blades, as in *Utricularia.* The following is worthy of remark: "The part situated upon the ampullæ is composed of somewhat elongated irregular cells, and exhibits peculiar bodies, such I have never seen before, and which, I think, have never been noticed by any botanist. These corpuscles, which are very numerous and close together, resemble a small open pair of scissors, as four arms are easily recognised in them, which are connected in the centre by a kind of knot." I have found these scissor-like plates.

On the Surface of the Stem and the Contents of the Cells of the Pith of Nuphar lutea Sm. By J. Münter. Bot. Zeit., 1845, 505.—The author has made the remarkable observation that the pits in the stem (cormus), beneath the scars of the petioles, are caused by roots which separate spontaneously; a phenomenon which has not previously been observed in the vegetable kingdom. In the cells of the pith, he detected the same forms of starch which he had previously observed in *Alstræmeria.*

Researches upon the Structure and Development of Nuphar lutea. By M. Aug. Trecul. Ann. d. Scienc. nat., 3 sér. vol. iv, 286.—An anatomical memoir, much of the contents of which is very excellent. The author's views are rather too special in investigations of this kind, and it would occupy far too much space to criticise this memoir.

On Clandestina Europæa. By M. Duchartre. Compt.

rend. 1844, i, p. 93.—This paper contains a statement to the effect, that stomata exist upon the leaves and young stems of *Clandestina Europæa.* There is a Report upon the complete Memoir in the 'Compt. rend.' 1845, i, p. 1268. The so-called *étui médullaire* is absent in *Clandestina,* neither do medullary rays exist.

Note upon Orobanche Eryngii, Vauch. By M. P. DUCHARTRE. Ann. des Scienc. nat., 3 sér. vol. iv, p. 74. —This plant is furnished with stomata. On the absence of medullary rays.

In the second part of my 'Lectures on Botany,' many details regarding the structure of the stem are contained, which, as far as I am aware, are not stated elsewhere. It was my wish not to have spoken of them when treating of the stem in this Report, because I have been found fault with for having alluded too frequently to myself. But I was very anxious that many points, as e. g. the wedges in the wood and in the bark, and the difference between them, and their difference from the medullary rays, should not be overlooked.

FERNS. MOSSES. LICHENS. ALGÆ. FUNGI.

New Species of the Genus Isoëtes, from Algeria. Described by BORY ST. VINCENT. Compt. rend. 1844, i, 1167.—They consist in addition to *Isoëtes Delilii,* of *Is. longissima,* from bogs, and *I. Duriei* and *Hystrix,* terrestrial species. Bory quotes Cl. Richard as having stated that the Isoëteæ should constitute a separate natural order; this would also apply to *Salvinia* and *Pilularia.* Roeper in his Flora of Mecklenburgh, pt. i, 1843, which contains much excellent matter, particularly special remarks upon Ferns, has censured me for arranging the Lypodiaceæ among the Ferns, and the same may be said of the Equisetaceæ. But I should wish the whole to be united into one class, because the orders composing

it are, as it were, the representatives of a Flora of the former world at a certain period. Moreover they bear the characters of these plants; everywhere we find imperfectly developed structures, not yet separated; the internal structure of the stem of the Lycopodiaceæ is that of a root, the frond is both a stem and a leaf; the male and female sexual organs are still conjoined in the Salviniaceæ, &c.

Moveable Spiral Threads in Ferns. By C. NÄGELI. Zeitschr. f. wissenschaft. Botanik, Hft. i, p. 169.—On the under surface of the germinal leaf, at its margin, more rarely also upon the upper surface, occur glandular organs. They frequently appear to consist of a single cell only; we generally recognise that it is a sac, composed of a single layer of cells. This sac is filled with apparently granular and opaque contents; it bursts at the top, and allows a number of small round cellules to escape; these cellules move actively in water. Each contains a spiral thread, which is set free by the rupture of the membrane of the cellule, and then exhibits the same movements as the seminal filaments of the Mosses, Liverworts, and Charas. An interesting addition to the observations which have already been made upon these Entophytes.

Lamellæ of the Leaves of Mosses. By C. MÜLLER. Linnæa, vol. xviii, p. 99.—The elevated ridges which are found upon the upper surface of the leaves of several Mosses on the side of, and in connexion with the nerves, were first accurately described by Treviranus, and are again minutely treated of in this paper. They consist of a row of remarkable cells; they do not seem to be of any use; they are connected with formative principle.

On the Development of the Sporidia in the Capsules of Mosses. Dissert. Inaug. scr. Bo. Jung. Scato. GEORG. LANTZIUS BENING. Gött. 1844.—An excellent contribution to the investigation of Mosses. The arrangement of

the sporidia in groups of four, in the form of a tetractys, has often been observed since Mohl described it, but their formation has never been traced so accurately from its earliest origin, as by the author. His observations show that the development of sporidia in the capsules of the Mosses, is effected by a frequently repeated formation of cells within cells, which takes place four times in *Polytrichum*, three times in *Hypnum*, but only twice in several other Mosses. It could not be satisfactorily determined whether the separation of the cells was produced by internal walls, or the granular matter; probably both contribute to it; a wall is formed on the separation of the nucleus. The formation of cells within cells never occurs during the simple course of vegetation, but this is the case where vegetation returns to generation.

History of the Growth of Mosses and Liverworts. By C. Nägeli. Zeitschrift f. wissenschaft. Bot., pt. 2, 138. —The history of the growth of *Echinometrium* and several other Liverworts does not admit of an abstract.

G. Mettenius, *Contribution to the History of the Development of the Moveable Spiral Fibres of Chara hispida.* Bot. Zeit. 1845, p. 17.—"The two antennæ which Thuret constantly observed, I have not been able to find," says the author;—I have seen them, and this entirely alters the matter.

Identity of the filamentous and mucoid Confervæ. By Dr. Schaffner. Flora, 1844, p. 568.—Rendered probable, but not proved. These minute objects certainly much resemble each other; they are Fungi, not Confervæ.

Caulerpa prolifera Ag. By C. Nägeli. Zeitschrift f. wissenschaft. Botanik, pt. i, p. 131.—*History of the Development of Delesseria Hypoglossum.* By the same author. (Ibid. pt. ii, p. 121.)

As regards the Algæ, descriptive coincides so closely with physiological botany, that the two must be arranged near each other. We find, in the 'Annals of Natural History,' vol. xiii, p. 375, RALFS, *On British Desmideæ;* vol. xiv, p. 240, DAV. LANDSBOROUGH, *On the Fructification of Gloiosiphonia Capillaris;* ibid. pp. 256, 361, *On British Desmideæ* continued.

The following papers are important as regards the description of the Algæ: *On the Structure of Ctenodus, Delisea, and Lenormandia.* By M. MONTAGNE. Annal. d. Sc. nat., 38, vol. i, p. 151.—*Note upon some Algæ with reticulated Fronds.* By M. J. DECAISNE. Ibid. vol. ii, p. 233.—*Note upon the mode of Reproduction of Nostoc verrucosum.* By M. GUST. THURET. Ibid. p. 319.—*Observations on the Tetrasporæ.* By M. M. CROUAN. Ibid. p. 365.

On the Colour of the Red Sea. By M. MONTAGNE. Ann. des Sc. nat., vol. ii, p. 332.—Account of it, and confirmation of Ehrenberg's earlier investigations. It is produced by an Alga, which Ehrenberg denominated *Trichodesmium erythraceum.*

On the genus Ceramium and some of its Species. By Prof. MENEGHINI. Giorn. Encicl., i, p. 178.—A criticism of Kützing's Memoir in the 'Linnæa,' vol. xv. Professor Meneghini works principally at the Algæ.

On the History of the Development of Chara. By C. MÜLLER. Botan. Zeit. 1845, p. 393 et seq.—The formation of cells has been treated of at some length above. This paper principally consists of a history of the development of the cells of *Chara* from cytoblasts.

On Hæmatococcus pluvialis. By J. V. FLOTOW. In the Memoirs of the Royal Academy of Naturalists, b. xii, sect. 2, p. 413.—An important memoir. The author

describes, with great care and accuracy, the transformations of a small Alga, or a small Infusorium, *Hæmatococcus pluvialis*, into the most varied forms. A red matter was first found in the rain-water from a surface of granite (at Hirschberg); this consisted of extremely delicate globular, shining vesicles, filled with a mass which, in its moist state, was granular, and of a carmine red colour; when dried upon paper, it was of a vermilion red colour. These granules not only experienced a change of colour, becoming greenish after some time, but at the end of September and the commencement of October, movements commenced in the granules. These consisted of— 1, Motion in the direction of a curve (longitudinal motion); 2, Rising and sinking in serpentine lines; 3, A rotatory motion. Water removed from the above cavity was then examined from time to time, and the altered forms studied, examined, and described with extraordinary accuracy. On the 30th of November filaments began to be formed; on the 13th of December he examined some of the rain-water which had been taken on the 9th of October, and subsequently kept in a warm room; he then found an infusorium, *Astasia pluvialis*, in it, which is nearly related to *A. nivalis* Shuttlew. I cannot dispel the idea, says he, that this *Astasia* arose from the *Hæmatococcus*, and that it is only a higher stage of development. Its agreement in form and contents with the *Hæmatococcus* globules themselves, the number of intermediate forms, composed of perfectly round figures, which from the first become slightly oval or ovale, afterwards more and more so, and sometimes are free from tubercles, at others bear them, almost entirely preclude the formation of an absolute line of demarcation between the phytonomic or infusorial animated individuals. This *Astasia pluvialis* is not seen to be produced in any kinds of infusion which do not contain *Hæmatococcus pluvialis*, the presence of which is a necessary condition to its formation. Moreover, a constant reciprocity is observed to exist between the two; the *Astasiæ* increase by sub-

division, but their embryo in part again assumes the form of *Hæmatococcus*. I must at least assume this to be the case. Thus the author saw the *Hæmatococcus* increase in vessels which were set aside, and attach itself to their sides. He also perceived infusiorially-animated individuals among them; but he never saw the *Hæmatococcus*, which was then at rest, subdivide. He separated the *Hæmatococcus*, and then found that every change of temperature, or of the water, provided the latter was pure, and the globules had acquired maturity, produced an alteration in the *H. pluvialis*. Experiments detailed with the same extreme minuteness follow the observations. They were performed with infusions of *Hæmatococcus*, and contain a number of very remarkable observations upon the various forms which this being produces; but we must refer the reader to the memoir itself. The author is uncertain whether he should refer *Hæmatococcus* to the animal or the vegetable kingdom, but concludes in favour of the latter opinion.

The same subject is treated in a shorter paper: *On the Conversion of Infusoria into the lower Forms of the Algæ.* By Dr. Fr. Traug. Kützing. Nordhausen, 1844, 4.—After some historical remarks, in which Flotow's memoir is also quoted, the author communicates some observations, the result of which is, that *Chlamidomonas pulvisculus* is susceptible of numerous changes; that a decided species of Algæ, *Stygeoclonium stellare*, is developed from it, but that other formations also emanate from it, which likewise decidedly have the characters of the Algæ, although from their external form they might in part lay claim to being considered as infusorial forms in a state of rest.

In conclusion, says the author: "The natural history of organisms has hitherto been treated of by two methods, according as the object is considered as perfected, or in a transient state. Linnæus may be regarded as the discoverer of the defining method in natural history, and

Göthe as the discoverer of the exponential method." Why does the author, who is remarkably clear-headed, make use of such expressions as these? Can a body be considered as in a state of formation when we are ignorant of what it is destined to become? Must we not always commence with the defining method, and then pass to the exponential? Have not all natural philosophers done so? Were not the species of frogs and salamanders first determined? Was this not necessary to avoid confusing the metamorphoses which they undergo in their early stages? Again says the author: "Some of our philosophers assert that it is necessary for us to assume well-defined limits between plants and animals, since without this assumption science would degenerate into fantastic mysticism." Now this is not exactly the case.

But when I distinguish plants from animals, I must know by what means I do so. Ehrenberg adopts the character of an animal originally proposed by Blumenbach, —the presence of a cavity (stomach), from which the entire being is nourished. This is not the place for discussing whether this is correct or not. Ehrenberg would ask, has *Hæmatococcus* a stomach? No: then it is not an infusorial animal, but a portion, the seed of one of the Algæ, which must undergo several metamorphoses before it is perfectly developed. For the same reason, the spore of *Ectosperma* (*Vaucheria*), with its cilia, is not an animal, but, as Unger correctly states, in a state of transition to the animal condition; that is, as far as we can judge from its possessing motion. Observations and experiments, such as those detailed by Kützing and Flotow, are of great importance; but I should prefer a somewhat simpler path than the latter has followed.

On the Cells containing Spiral Fibres in Fungi. Bot. Zeit., 1844, p. 369.—The author, Professor von Schlechtendal, after reporting what has already been stated upon this point by Roman. Hedwig, and subsequently Corda, details his own observations upon some dried

Trichiæ. The cells are either not very long, and in that case pointed at both ends and contain few spirals, by means of which the walls of the cells are, as it were, expanded; or the cells are very long, divaricately ramified, and intricately interlaced with each other. Moreover, the spores have always a larger diameter than the cells containing the spiral fibres, which require high magnifying powers for their observation.

On Lanosa Nivalis Frs. By Professor UNGER, of Grätz. Bot. Zeit., 1844, p. 369.—This remarkable white filamentous Fungus, the reddish separating sporidia of which were first described by the author, having only been mentioned by Fries and Corda, occurred in large quantity beneath the melting snow at Grätz, at the end of February and the beginning of March. The author ascribes the sudden vegetation of this Fungus to the circumstance, that notwithstanding the heavy fall of snow in January and February, the ground was still not frozen.

A sick woman, who was principally suffering from difficulty of deglutition, vomited some sporidia of a fungus; these were sometimes arranged in a moniliform manner. H. Gruby satisfied himself, that all the nourishment she took was fresh and good. Compt. rend., 1844, i, p. 586.

Occurrence of Cysts, containing Filamentous Fungi, in the Internal Ear of a Young Woman. By Professor MEYER. Muller's Archiv, 1844, p. 404.—The description and figure distinctly show that this was *Mucor Mucedo.*

The Report of the Swedish Academy of Sciences for 1844, contains an instance of *Achlya prolifera* producing the death of fish. My friend Lichtenstein sent me a small Cyprinus Alburnus, the mouth of which was entirely closed by the growth of *Achlya prolifera.* Almost

all the fish in the pond had been destroyed by this growth. On examining it, I found that the difference stated to exist between *Achlya* and *Saprolegnia* is incorrect, for several filaments had transverse walls, many not.

Identity of the Mucoid and Filamentous Confervæ. By Dr. SCHAFFNER. Flora, 1844, p. 567; also Flora, 1845, p. 501.—In an appendix to his remarks upon the Mucoid Confervæ, Dr. Schaffner states that this plant is *Byssocladium fenestrale.* He also found this *Byssocladium* in the expectoration of a patient suffering from pulmonary tubercle. The pulverulent crusts of *Porrigo leprosa,* as well as those of scrofulous scald-head, also consist of a variety of *Byssocladium fenestrale.* 'Flora,' 1845, p. 501. There is no doubt that many of these Fungi are still imperfectly developed. How many *Rhizomorpheæ* do not consist of the thallus of *Merulius* (*Xylophagus vastator*), the dry-rot! Still more remarkable are the filaments which are developed in syrup preserves, and even in solutions of the tartrates. They must be allowed to grow for a long time before we can recognise them as belonging to *Penicillium glaucum.* I cannot too strongly recommend that these Fungi should be left undisturbed, so as to allow of their true fructification being discovered. Hitherto, there has been much confusion on this subject. Nothing decidedly botanical has been published upon the Fungi found in fermenting fluids.

MONSTROSITIES.

On some Abnormally-developed Leaves. By the Editor, VON SCHLECHTENDAL. Bot. Zeit., 1844, p. 441, 457.—Contains a notice of some abnormally-developed leaves which were observed; hence it does not permit of an extract.

The monstrosities described by Kirschleger would require to be detailed in full. *Vide* 'Flora,' 1844, pp. 129,

566, 728; 1845, pp. 402, 613. I may mention, also, the "Antholyses" of Valentin, N. Act. Acad. Leop. 18, i, 223; Duchartre's two cases in Ann. d. Scienc. Natur. 3 sér., vol. i, p. 292; and those of Cappari, Giorn. Encicl., vol. ii, p. 261.

Upon a very Rare and Special Ramification of Yucca Aloifolia L. By ANTONIO PRESTANDREA, of Messina. Messina, 1845, p. 8.—Such ramifications are by no means rare, especially in warm climates. I have frequently observed the ramification of the scape of *Agave Americana* below the inflorescence, in Messina.

A Monstrosity of Primula Sinensis, in which a cup-shaped body upon which the naked placenta was situated, occurred upon the style, is very remarkable. Babington, Ann. of Nat. Hist., xiii, p. 464. Dr. Dickie describes several monstrosities in *Gentiana campestris,* ibid. xv, 87.

Monstrosities in Digitalis purpurea through several generations, observed by Vrolik. Flora, 1844, i.

Professor von Schlechtendal's *Remarks upon a Monstrosity of the Capsule of Papaver Somniferum,* are also extremely interesting. Bot. Zeit., 1845, p. 6.

REPORT

ON THE PROGRESS OF

GEOGRAPHICAL BOTANY,

DURING THE YEAR 1844.

August (Heinrich Rudolph)
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GEOGRAPHICAL BOTANY.

In the first volume of the 'Physical Atlas' of Berghaus, which is now completed, six sheets are devoted to graphic representations in the department of Botanical Geography. The first sheet, entitled 'Outlines,' forms a sequel to the works of Humboldt and Schouw, and refers principally to the geographic subdivision of vegetable formations; in the vertical direction it illustrates the serial gradations of the regions, whilst in the horizontal direction it shows the areal boundaries of the natural Floras. This representation, however, appeared as early as 1838, and on future revision would require considerable improvements. The second sheet, which treats of the Districts in which the most important products of culture are distributed, is of greater interest. Its design consists in an attempt to subdivide the province of agriculture throughout the entire inhabited surface of the earth, according to the kinds of Cerealia which predominate, whence general relations are found between the climate and the productive power of different countries. In the Old World the author distinguishes the following zones between the polar limits to agriculture and the equator.

1. Zone of barley and rye. It might with propriety be called the zone of the summer Cerealia, inasmuch as the duration of the winter is the most important condition which prevents the culture of the more productive

and certain winter corn. In this more comprehensive point of view, the separate denomination of the South of Scandinavia as the district of the exclusive cultivation of rye, and of Scotland as that of barley, disappears, as circumstances not founded upon climatic conditions.

2. Zone of rye and wheat. This is considered as extending southwards to about the fiftieth degree of latitude, or as far as the polar limits of the cultivation of the vine.

3. Zone of wheat. To this, those parts of Europe and Western Asia belong which lie south of the fiftieth degree. In several districts maize is cultivated as well as wheat.

4. Zone of rice and wheat in those provinces which are subject to the influence of tropical seasons. In tropical Western Africa rice and maize occupy the place of the former.

In America, where these relations are modified by the greater extent to which maize is cultivated, Berghaus distinguishes the following zones: rye, wheat, and barley (i. e. summer Cerealia); rye and maize; wheat and maize; wheat; in the tropical zone maize is the principal cereal grain. With these sketches the author has combined indications of the distribution of other nutritive plants, and has illustrated, in separate charts, the districts in which the most important plants of commerce are produced. The two following sheets contain the statistical numerical proportions of the Flora of Europe, which, not being susceptible of tabular arrangement, and being subject to very important differences in the views taken of the definition of the species and botanical groups, were not adapted, in the present state of botanical geography, to graphic representation. Although the same applies still more to the last sheet upon Germany, which appeared in 1841, nevertheless the review of the polar and equatorial limits of numerous woody and cultivated plants in Europe, deserves great praise, inasmuch as the observations made use of in it have appeared to us,

on the frequent use of this chart, very numerous. Moreover, many of the sheets intended to illustrate meteorological relations appear indispensable also to the botanist.

M. Römer has commenced the publication of a Memoir entitled 'Botanical Geography and Geographical Botany,' which treats of the subdivision of the surface of the earth into natural Floras. (Lüdde Zeitschr. für vergl. Erdkunde, Bd. iii, pp. 527-534.)

A paper by E. Fries, entitled "The Native Land of Plants," in his peculiar style, the special interest of which is confined to the Swedish public, but also frequently touches acutely more general questions, treats of different botanico-geographical subjects, especially of the native country of the so-called ruderal plants. (Botaniska Utflygta, Bd. i, pp. 229-328, translated in Hornschuch's Archiv Skandinav. Beiträge zur Naturgesch. Bd. i, H. 3.) The *original* native country of many cultivated plants cannot now be determined by empirical proof, but only by rational investigation. Thus rape is no longer met with in its wild state, but when we adduce proof from all extra-European countries that it is not indigenous to them, we must conclude that it is of European origin, although its wild state has disappeared through cultivation. Many plants have been extirpated by use; this is now gradually taking place with *Gentiana lutea*, in the Alps, and *Inula Helenium* in the west of Sweden. The contact of Nature with man exerts no less a modifying influence upon the vegetable kingdom than upon the animal creation. The original vegetation of a country must in general, therefore, be regarded as more rich in species, and in this manner in Sweden and Germany, even under our own eyes, the localities of rare plants are disappearing one after the other, as e. g. of *Trapa*, *Xanthium*, and *Stipa*.

The excellent work of A. Wagner, on the 'Geographical Distribution of the Mammalia,' (Abhandlungen der mathem. physik. Klasse der Bairischen Akad. Bd. iv), which belongs to an allied province, but was not designed without regard to the geographical relations of other organisms, must not be passed over here without notice. The question of the original native country of the various organisms is acutely investigated by the author, and it is found that the distribution of animals, as of plants, cannot be satisfactorily explained by the climatic and local conditions of their existence, but that the most rigid facts, together with the physical relations at present in existence, point to other, perhaps historical causes, with which we are at present unacquainted, and which the author considers as the effects of a general order of the creation, which ought, however, rather to be kept in view *by us* as objects worthy of future investigation. From the observations, in Belgium, upon the Periodical Phenomena of Vegetation, published by Quetelet, and mentioned in the previous Yearly Report, the following brief extract, containing the period of the appearance and fall of the leaves, in the year 1841, of some generally diffused woody plants, may be of use in the determination of the Phyto-isotherms of Northern Europe; and for this purpose it will be conjoined with some observations simultaneously made by Hartmann, in Gefle (60° N. l.) (Bot. Notis. 1842.)

	Appearance of the Leaves.				1841. Fall of the Leaves.	
	Gefle.	Brussels.	Lyons.	Ghent.	Brussels.	Ghent.
Æsculus	15 May	...	29 March	...	25-30 Oct.	24 Oct.
Acer	...	23 April	...	27 March	25-30 Oct.	...
Vitis vinifera	...	23 April	...	...	10-15 Nov.	...
Tilia europæa	21 May	26 March	...	24 March	20-25 Oct.	12 Sept.
Juglans regia	...	27 April	...	25 April	...	3 Oct.
Prunus Cerasus	...	27 March	...	...	...	27 Oct.
Pyrus Malus	...	24 March	...	17 March	1-5 Nov.	29 Oct.
Sorbus aucuparia	12 May	...	...	...	...	..
Ribes Grossularia	...	12 March	17 March	14 March	...	...
Ribes rubrum	...	18 March	20 March	17 March	. .	...
Sambucus nigra	...	16 March	15 March	14 March	5-10 Nov.	24 Oct.
Syringa vulgaris	...	12 March	15 March	17 March	5-10 Nov.	24 Oct.
Fraxinus excelsior	25 May	...	...	...	...	...
Daphne Mezereum	3 May	16 March	24 March	...	...	...
Ulmus campestris	22 May	29 March	...	26 March	1-5 Nov.	31 Oct.
Salix babylonica	...	17 March	24 March	17 March	15-20 Nov.	...
	...	1 April	...	...	20-25 Oct.	24 Sept.
	19 May	...	...	...	...	...
Corylus Avellana	16 May	24 March	25 March	18 March	...	27 Oct.
Quercus Robur	...	28 April	...	...	10-15 Nov.	...
Betula alba	14 May	27 March	...	...	1-5 Nov.	...
Alnus glutinosa	20 May	...	...	...	...	...

Of monographs upon individual groups of plants, in which attention is paid to their geographical distribution, published during the past year, the following require mention: Parlatore on the Fumariaceæ (Giornale Botan. Ital., i, p. 97 et seq.); v. Martius, on the Erythroxylaceæ (Bairische Abhandl., iii, pp. 325-32); Lomler, on the Distribution of the Coniferæ (Ratisbon Flora, 1844, pp. 440-3).

Fumariaceæ.—Only 13 species; these are distributed throughout both temperate zones, for the most part, indeed, secondarily transferred from one region to the other. With the exception of the Cape *Discocapnus*, they all grow in the South of Europe, between the 34th and 40th degrees of latitude, and diminish so rapidly from this zone in both meridional directions, that beyond the 50th degree, 3 species only are met with; a statement which, however, is not correct as regards Germany. Spain contains several endemic forms.

Erythroxylaceæ.—Of 58 species of the genus *Erythroxylon*, Brazil contains 29; the West Indies, 8; Guiana, 7; Columbia, 4; and Mexico and Peru, one each; hence tropical America contains 50 altogether: 5 species grow in Madagascar and the Mauritius, single representatives at the Cape, in the East Indies, and on the north coast of New Holland. In America the district of their distribution extends from the tropic of Cancer to that of Capricorn, in the Old World, from 15° N. lat. to 30° S. lat.

Coniferæ.—Lomler enumerates only 208 species. Of these, he calculated that 165 exist in the northern and 51 in the southern hemisphere; moreover, there are 22 in Europe, 87 in Asia, 16 in Africa, 83 in America, and 35 in Australia; lastly, 24 in the tropic zone, 159 in the north temperate, and 33 in the south temperate zone. These statements can only be regarded as preliminary steps to our knowledge on this point.

I.—EUROPE.

A work, containing copper-plate engravings of the plants of Russia, has been begun by Trautvetter (Plantarum Imagines et Descriptiones. Monachii, 1844, 4 fasc., 1-4; at present 20 plates). Also a continuation of the old 'Bieberstein Centuries' (M. de Bieberstein Centuria Plantarum Rossiæ Meridionalis Iconibus illustrata; Pt. ii, Dec. 1-3. Petropoli, 1844,) has been commenced in St. Petersburg. Engelmann has published a paper upon the Genera of Plants found in the Russian provinces of the Baltic (Genera Plantarum, or the Genera of Plants growing wild in Esthonia, Livonia, and Courland; Mitau, 1844-8).

A. F. C. v. Fischer has written upon the botanical relations of Southern and Central Lithuania, especially in the circle of Sluzk (Mittheilungen d. Natur. Gesellschaft zu Bern, for the years 1843-4; Bern, 8). In the immediate neighbourhood of Sluzk, in the district of the source of the Niemen and several tributary streams of the Dnieper, the author only found about 600 Phanerogamia, a catalogue of which he gives, with remarks upon their statistics. In these districts, heathy plains, overgrown with *Calluna* (together with *Juniperus* and *Genista tinctoria*) are still common. Dwarf underwood, consisting of the oak (*Quercus pedunculata*) covers large spaces, and stamps the physiognomy of Lithuania towards the western districts of the Baltic plain. In moist low grounds *Salix angustifolia* and *livida* predominate. The large forests consist of pines or fir trees; the truly foliaceous trees, which are less common, are mostly birch, and in Polesia, the oak, which grows mixed with the birch, poplar, mountain-ash, &c. The following may be mentioned as geographically characteristic species: *Thalictrum aquilegifolium* L., *simplex* L., and *angustifolium* Jacq., *Anemone patens* L.,

Viola stricta Horn., *Dianthus arenarius* L., *Euonymus verrucosus* Scop., *Trifolium lupinaster* L. (in pinetis siccioribus raro), *Spiræa Aruncus* L., *Geum strictum* Ait., *Polentilla norvegica* L., *Agrimonia pilosa* Led., *Saxifraga Hirculus* L., *Cnidium venosum* Kch., *Chærophyllum aromaticum* L., *Inula Helenium* L. (in sylvis udis), *I. hirta* L., *Cirsium rivulare* Kch., *Andromeda calyculata* L., *Pyrola media* Sw., *Polemonium cæruleum* L., *Pulmonaria azurea* Bess., *Pedicularis Sceptrum* L., *Dracocephalum Ruyschiana* L., *Melittis Melissophyllum* L., *Amaranthus sylvestris* Desf., *Thesium ebracteatum* Hayn., *Euphorbia virgata* Kit., *Salix nigricans* Fr., *livida* Wahlb. (*depressa* Fr.), *myrtilloides* L., *versifolia* Wahlb., *lapponum* L., *Betula fruticosa* Pall., *Typha pendula* nov. sp.,* *Malaxis monophyllos* Sw., *Cypripedium Calceolus* L., *Gladiolus imbricatus* L., *Fritillaria* sp., *Veratrum Lobelianum* Bernh., *Tofieldia calyculata* Wahlb., *Carex divulsa* Good., *pilosa* Scop., *Hierochloa odorata* Wahlb., *Calamagrostis stricta* Spr.

Wahlberg has published some remarks upon the plants of Quickjock in Swedish Lapland (Öfversigt af Kongl. Vetenskabs-Akademieens Förhandl., 1844, p. 23). *Rubus castoreus* Laestad. is a bastard of *R. articus* and *saxatilis* occurring in two forms.

Lindblom has published some observations upon the Botanical Relations of Norway (Bot. Notiser., 1842-3.) In the outset, we meet with the unfounded assertion, that in most of the regions of the coast of Norway, Alpine plants extend as low down as the level of the sea; an occurrence which is limited to individual species only, and may be compared to the growth of Alpine plants on the Isarkies, near Munich. This statement, made by Lindblom, is one of those erroneous generalizations, borrowed by one person from another. Alpine plants do not occur in Norway below the limit of trees, any more

* T. spicis cylindricis, masc. et fœm. contiguis, foliis planis linearibus culmo longioribus pendulis. (An. T. Shuttleworthii, Kch. ?)

than in the Alps. Then follow observations upon the limits at which plants occur in the direction from west to east, to which scientific value must be attributed, on account of the climatic contrasts between the internal districts and the western coast of the south of Norway.

a. Plants of the western coast, which, according to Lindblom, are not found in the inner district. (The polar limit of their distribution is expressed numerically according to the degree of latitude, their occurrence in Sweden is inclosed in parentheses).—

Fumaria capreolata. 59°.
Hypericum pulchrum. 63½°.
— *montanum.*
Vaerdal in Trondjem.
Vicia orobus.—62½°, i. e. the limit of the occurrence of the oak.
Sanguisorba officinalis. 60°.
(Isld. Gottland.)
Bunium flexuosum. 63°.
Myrrhis odorata. 63°.
Chryosplenium oppositifolium.—62½°.
Rosa pimpinellifolia. 60°.
Ilex aquifolium. 62½°.
(Bohuslän.)
Galium saxatile. 62½°.
(South of Sweden.)
Centaurea nigra.—
Snaasen in Trondjem.
Hypochæris radicata. 62½°.
(— Bohuslän.)
Erica cinerea. 62½°.
Pyrola media. 61°.
(— Bohuslän.)
Lysimachia nemorum.—63°.
(Schonen.)
Primula acaulis. 63°(=).
Digitalis purpurea. 63°.
(— Bohuslän.)
Lamium intermedium. 61°.
Teucrium Scorodonia. 59°.
Luzula maxima. 68°.
Carex binervis. 63°.
— *salina.* 70°.
— *maritima.* 70°.
Aira præcox. 62½°.
(— Bohuslän.)
Bromus tectorum. 61°.
Brachypodium gracile. 62½°.

b. Plants belonging to the western coast, which occur only on the southern coast, e. g. at Christiania, or in the valleys of the Fjeldplateaux, but not in the true inner districts of the south of Norway.—

Arabis petræa.—62°.
Rosa pomifera.—63°.
(South of Sweden.)
Sorbus aria.—63½°.
(— Bohuslän.)
Sorbus hybrida.—62° (?)
(Gottland.)
Hedera helix.—60½°.
Lonicera periclymenum.—
Valderhong in Trondjem.
(— Bohuslän.)
Sambucus nigra.—
Valderhong. (— Bohuslän.)
Gentiana purpurea.—62½°.

Mentha sativa.—63°.
(South of Sweden.)
Fagus sylvatica.—61°.
(— Bohuslän.)
Quercus Robur.—62°.
According to Blom, 63°.
(South of Sweden.)
Allium ursinum.—63°.
(— Bohuslän.)

c. Inland plants of the eastern districts of southern Norway, which are absent on the western coast. (Excluding those of the Fjeld.)—

Pulsatilla vernalis.
Trollius Europæus.
Berberis vulgaris.
Astragalus glycyphyllus.
Ledum rupestre.
Galium trifidum.
Hieracium cymosum.
Pyrola chlorantha.
Dracocephalum Ruyschiana.
Thymus Chamædrys.
Pedicularis Sceptrum.
Salix daphnoides.
— *amygdalina.*
Carex capitata.
— *parallela.*

d. Plants of the Eastern Fjeld, principally observed on the Dovre-fjeld, but not found on the western coast (some species which I myself found at Hardanger, and which are therefore more widely distributed, are omitted in this list, viz. *Aconitum septentrionale*, *Draba hirta*, *Gentiana nivalis*, and *Salix arbuscula*).—

Ranunculus hyperboreus.
Lychnis apetala.
Alsine hirta.
Oxytropis lapponica.
Phaca oroboides.
— *frigida.*
Potentilla nivea.
Saxifraga cernua.
Saxifraga controversa.
Primula stricta.
Gentiana tenella.
Kœnigia Islandica.
Junctus arcticus.
Kobresia caricina.
Elyna spicata.
Carex microglochin.

A remarkable peculiarity of the highlands of Norway, and which is not merely indicated, but satisfactorily established by this catalogue, yet cannot be explained by means of the variations of climate pointed out above, consists in the fact that the Alpine vegetation appears to attain its maximum, as regards the number of species, on the Dovre mountains, and that it diminishes from this locality both towards the west and the south. Moreover in these directions the individual numbers of many cha-

racteristic species also become less, the Fjeldplateau gradually assuming the condition of a steppe. In this respect, Lindblom's observations on the desert of the Bygle- and Hekle-Fjelds, or the most southern part of the highlands, which were made many years ago, but are again brought forward in the present memoir, are instructive. The predominating plants of some tracts in this part, e. g. between Siredal and Lysefjord, are *Molinia cœrulea* and *Solidago virgaurea*, and these displace all others. The alpine plants of this region, as shown by the following list of them, also grow in Hardanger, and do not resemble those of the Brocken or the Sudeten, to which, among the whole of the Scandinavian mountains they are most nearly situated.

Ranunculus pigmæus.
Arabis alpina; Cardamine bellidifolia.
Silene acaulis; Lychnis alpina; Stellaria alpestris; Cerastium trigynum alpinum; Sagina Linnæi.
Epilobium alpinum, alsinifolium.
Dryas octopetala; Potentilla maculata; Sibbaldia procumbens; Alchemilla alpina.
Rhodiola rosea.
Saxifraga Cotyledon, stellaris, aizoides, rivularis, oppositifolia, nivalis.
Saussurea alpina; Hieracium aurantiacum, alpinum.
Phyllodoce taxifolia; Cassiope hypnoides; Arctostaphylos alpina; Loiseleuria procumbens.
Gentiana purpurea.
Veronica alpina, saxatilis; Bartsia alpina.
Oxyria reniformis.
Salix glauca, Myrsinites, Lapponum, retusa, herbacea.
Betula nana.
Tofieldia borealis.
Juncus biglumis, trifidus; Luzula arcuata and *spicata.*
Aira alpina and *atropurpurea; Poa alpina; Phleum alpinum.*
Carex rariflora, pulla, lagopina, rigida, vaginata, atrata, rotundata, capillaris and *alpina; Eriophorum capitatum.*
Lycopodium alpinum.
Polypodium alpestre.

The second section of Lindblom's memoir treats of the distribution of the Norwegian Ferns, which, according to theory, ought to be more common on the western coast

than in the inland districts, but which, in fact, do not correspond to this view. The author is certainly of an opposite opinion, and states that the number of individuals increases towards the west, which I should much doubt; but it is certain that *Hymenophyllum Wilsoni* can alone be considered as an evidence of the marine climate, whilst the inland country contains five more of the thirty-three ferns which are here enumerated than the west, viz. *Polypodium calcareum; Aspidium Thelypteris, cristatum, montanum,* and *crenatum* Sommf. On the western coast, *Aspidium aculeatum* and *Asplenium adiantum nigrum,* which are not found in the east, extend as far as Trondjem, but they must be considered as forms belonging to the south, not to the coast.

I can only refer here to my paper upon Hardanger (see Wiegm. Arch., p. 1-28); still I cannot omit this opportunity of replying to the editor of the 'Botaniska Notiser' (see that journal, 1844, appendix, p. 64), that the beech is certainly cultivated beyond Christiansund. Blom, whose authority is Blytt, makes this statement. (Das Königreich Norwegen. Leipz., 1843, p. 48.) I did not say that it grew wild there, as Lindblom has erroneously stated in his translation, and the only object I then had in view, was to show how far north the climate was suitable to the growth of that tree. I found single specimens of *Helianthemum alpestre* on rocks near the herdsmen's hut Oppedals-Stölen, and have given specimens of *Phippsia* from the same region to several botanists. However, I place little value upon these new localities, of which I had several, and I should consider it as the best recompense for the labour of my memoir, if Lindblom and other able Scandinavian naturalists, instead of filling their Journal with unsatisfactory lists of the results of their excursions, and critical minutiæ regarding the distinction of species and their nomenclature, were also induced by it to direct their scientific attention more and more to the conditions of the distribution of plants in the North of Europe.

Blytt, whose Flora of Norway has long been in prepa-

ration, but is still looked for in vain, has published a Catalogue of the Plants growing wild at Christiania (Enumeratio Plantarum, quæ circa Christianiam sponte nascuntur, Christiania, 1844, p. 4). It contains 790 vascular plants. Fries has continued the publication of his Critical Remarks upon Swedish plants and their stations (Bot. Notis. 1844, p. 1, 49, 75 et seq.) Parts ix and x of his Normal Herbarium have appeared. Anderson and Lindblom have worked at the Alpine *Epilobia* of Sweden (id.) Ångerström has issued some contributions to our knowledge of the Scandinavian Mosses (Nov. Act. soc. Upsal. 12, pp. 345-80).

Lindblom's Botaniska Notiser also contains the following Memoirs upon the Topography of Swedish plants: Borgström, Contributions to the Flora of Wärmeland (1842); Lindgren and Torssell, Mosses of Upsal (1842-3); Forssell, Catalogue of the more rare Plants which occur in Norrtelge (north-east of Stockholm) (id.); Hofberg, Localities at Strengnäs on the Lake Malern (1842-3); Von Post, Botanical Conditions of the Western Bank of Lake Malern (1844), of some interest, on account of the careful observation of the localities in which 480 phanerogamous plants are distributed; Hamnström, New Localities in Nerike (1842); Lindgren, Localities at Lake Wener, with critical remarks (1842-3); Holmgren, Kalén, and Hamnström, Localities in East Gothland (1841-3); Lagerheim, the same in West Gothland (1844); Sieurin, Diary of Travels in North Holland, containing habitats (id.); Lindblom and Borgström, Habitats at Schonen (1843-4). Nyman has published Contributions to the Flora of Gothland, by which the number of vascular plants found upon this island is increased to more than 800 (Vetenskaps Akademieens Handlingar för år 1840, pp. 123-51). The results of Beurling's voyage now communicated in these Memoirs, are confined to lists of localities, principally in Jemtland; they are copiously detailed as regards the mountain Åreskuten.

On the death of C. E. Sowerby, the proprietor of the

'English Botany,' his successor, J. D. C. Sowerby commenced a new series of the parts of this illustrated work, of which, with the aid of Wilson, Berkeley, Babington, and Borrer, up to 1844, the first three parts have appeared (Supplement to English Botany, second series, Nos. 1-3. London). The Botanical Society of London, following the example of that of Edinburgh, have published a catalogue of British plants (The London Catalogue of British Plants, published under the direction of the Botanical Society of London. London). In consequence of critical elaboration, this catalogue contains considerably fewer species (1305 indigenous, and 132 acclimated phanerogamia) than the Edinburgh one, and is ascribed to the pen of Watson. The 'Phytologist,' a journal which was noticed in the yearly report for 1842, is still continued. I may refer to the list of contents given in the 'Botanische Zeitung.'

Watson has made some critical remarks upon individual British plants (London Journal of Botany, iii, pp. 63-81). Newman has issued a description of British Ferns (A History of British Ferns and allied Plants. London, 1844). 'The Annals of Natural History' (vol. xiii, xiv) contain the following contributions to the British Flora: Ball, on *Œnanthe;* Taylor, contributions to our knowledge of the *Jungermanniæ;* Harvey, description of the new Irish genus of Algæ, *Rhododermis;* Berkeley, contributions to Mycology; Dickie, critical catalogue of the Marine Algæ existing at Aberdeen; Spruce, catalogue of the Mosses and Hepaticæ of Teesdale, in Yorkshire; Salwey, of the Lichens of Wales; Graham, on the results of his journey through Wales; Babington, on the Irish Saxifrages.

Babington has shown that *Neottia gemmipara* Lm., the rarest of all the European Orchidaceæ, which was discovered by Drummond near Cork, in 1810, and has only recently been again found, is identical with the *Spiranthes cernua* Rich. of North America (Proceed. of the Linnæan Society, 1844).

Sande Lacoste, and Dozy have been occupied in the study of the cryptogamic plants of the Netherlands. The former has made known localities of the Mosses; the latter, in conjunction with Molkenboer, has published a catalogue of the Fungi indigenous to that country, and some newly-discovered Mosses (both in v. d. Hoeven's Tidjschrift, f. 1844, p. 165 and 377).

The general works upon the Flora of Germany, mentioned in the previous Annual Reports, have been continued. Four decades of the seventh volume of Reichenbach's 'Icones,' containing the Aroideæ and the allied groups, have appeared. A cheaper edition, containing a more copious text, was commenced at the same time, with the title of 'Deutschland's Flora;' Parts 23 and 24 of the third section of 'Sturm's Flora;' the fifth volume of Schlechtendal and Schenk's illustrated work; and Parts 48-56 of that upon Thüringia; Parts 34-49 of Link's Publication; and Parts 2-4 of D. Dietrich's 'Cryptogamia.'

Rabenhorst has published the first volume of a 'Cryptogamic Flora,' containing the Fungi (Deutschland's Kryptogamen—Flora. Bd. i. Leipzig, 1844-8). This compilation is adapted to the present time, but does not entirely come up to our expectations. Of the author's valuable collection of dried Fungi, the seventh, and in the following year the eighth, "Centurie" have appeared. Hampe is preparing a similar herbarium of the 'Cryptogamia of the North of Germany,' which comprises at present 230 Mosses, 80 Hepaticæ, and 80 Lichens. (By the author at Blankenberg, on the Hartz.)

In Wallroth's 'Contributions to Botany,' two parts of which are before us, individual genera of the flora of Germany are treated monographically; especially *Agrimonia*, *Armeria* (with two well-marked Hartz mountain-plants, *Agrim. odorata* D. C., Syn. *A. procera* Wallr., and *Armeria humilis* Lk., Syn. *A. filicaulis* Boiss.! *A. Halleri* Wallr.), *Lampsana*, and *Xanthium*. Then follow critical remarks; as, e. g., upon *Senecio paludosus*,

Salix hastata, from which Wallroth distinguishes the form which he discovered on the gypsum-chain of the southern Hartz mountains, as *S. surculosa*. Scheele has continued his work upon German and individual Exotic Plants, which was noticed in the last Annual Report (Ratisbon Flora, 1844, and Linnæa, 1844); and Petermann has followed him in attempts of the same kind, to contribute to our knowledge of native species (Ratisbon Flora, id.).

Provincial Topographies and Sketches of the Vegetation in the Province of the German and Prussian Flora:—Kamp, Catalogue of Plants growing wild around Memel (Preuss. Provinzialblätter, 1844, p. 451-569); Leo Meier, On the Flora of Gerdana in Eastern Prussia (Bot. Zeit., 1844); Roeper, Contributions to the Flora of Mecklenberg (Part 2, Rostock, 1844), representing the Graminaceæ in the manner pointed out above; Fiedler, Synopsis of the Mosses of Mecklenberg (Schwerin, 1844-8); Häcker, Flora of Lübeck (1844-8); K. Müller, Contributions to a Cryptogamic Flora of Oldenburg (Bot. Zeitung, 1844), with additions and corrections by H. Koch (id.); Wimmer's Flora of Silesia, which was mentioned in the Annual Report for 1840, has appeared in a second and enlarged edition (Breslau, 1844); Reichenbach, Upon the Botanical Conditions of the Flora of Saxony (i. e. Gaea of Saxony, 1843-8), contains nothing more than a catalogue of rare plants from the separate districts, in the form of extracts from the author's 'Flora Saxonica;' Pfeiffer, Sketch of the Plants hitherto found in Kur-Hesse (Cassel, 1844-8); this is to be regarded as preliminary to a critical Flora of Hesse, and contains a large number of new localities, especially on the basaltic mountains of Cassel; by the same author, A few words upon the Subalpine Flora of Meissner (loc. cit., 1844); Wirtgen, Supplements to the Flora of the Prussia Rhine Provinces (Verhandlungen des naturhistorischen Vereins der Preussischen Rheinlande, Jahrg. 1); Thieme, Catalogue of the Plants growing at

Hainsberg, in the Territory of Aix (Ratisbon Flora, 1844, p. 209-21); Löhr, Manual of the Flora of Trêves and Luxembourg, with a notice of the surrounding districts (Trêves, 1844-8); Lechler, Supplement to the Flora of Würtemberg (Stuttgard, 1844-8); Sailer, Flora of Linz (Linz, 1844-8), an extract from the Flora of Upper Austria, mentioned in the Annual Report for 1841; Sauter, Report upon a Journey to Lungau (Ratisbon Flora, 1844, p. 813-16).

E. v. Berg, at Lauterberg, on the Hartz mountains, endeavoured to prove that the Coniferæ are gradually becoming more widely distributed in the north of Germany (Das Verdrängen der Laubwälder durch die Fichte und Kiefer. Darmstadt, 1844-8). The fact, in the case of the Hartz mountains, rests upon authentic testimony; but how far this change, which in many places has been completed in the space of twenty years, has been produced by external natural conditions, or merely by the economic management of the forests, is difficult to ascertain. In Lüneburg also, where, e. g., in the struggle between the two methods of culture, it was not decided in favour of the pine until after the lapse of a century, as also in Solling, on the Upper Weser, where deciduous forests are still very extensive, the same conditions have prevailed as on the upper Hartz mountains. On the western Hartz mountains, the red pine generally succeeds the beech; but in some parts, on the removal of the latter, the remains of oaks have been found as high as a level of 2000′, i. e. an elevation at which they have long since ceased to grow. When we consider that the tree-limits on the Hartz mountains lie extremely low, in comparison with those of the north of Europe, and that even the Coniferæ do not ascend higher on the Brocken mountains than at 9—10° further north in Norway, the fact of the culture of the oak and beech at a former period, would render it, at any rate, tolerably probable that secular changes had taken place in the climate, by means of which the distribution of the forest trees had been

produced, and by which Steenstrup's succession of forest growth in maritime countries would be brought into connexion with the extermination of the Coniferæ in the elevated regions of the upper Hartz mountains.

The work of Fuchs, on the Venetian Alps, contains an account of the limits of vegetation in the southern dolomitic Alps, especially the district of Agordo; it fills up an important gap in the observations upon the vertical distribution of the Alpine plants (Vienna, 1844, fol.) Unfortunately, however, in the case of most of the plants, the lower limits of altitude only are given; and of these, a local value only can be attributed to many measurements. The results, expressed in French feet, are as follows :—

a. Upper limits.

Ficus Carica, and limit of the cultivation of the *vine*, 1500′. (At Agordo, *Vitis* grows very luxuriantly at a level of 2000′, but no wine is made.

Castanea vesca, 2000′ at Agordo.

Juglans regia, 3500′ at Frassene.

Zea Mays, 2500′ in the valley of Cordevolethal.

Cerealia, excluding wheat, 4400′ at the Col di S. Lucia; 4600′ at Buchenstein.

Dense Forest of Coniferæ, 5500′. In the regions of the mountain-pine, individual larches and fig-trees; 6309′ at Sasso di Palma.

Fagus sylvatica, 5000′; e. g. at Monte Luna, 4915′, still higher at Bosco Medona and in the Val Pegolera.

Pinus Cembra, 6665′ at the Col di Lana.

Upper limit of the Phanerogamia, = 9000′; *Aretia Vitaliana*, and some Saxifrages.

b. Lower limits.

Ranunculus aconitifolius, 3500′.
montanus, 7000′.
glacialis, 8000′.
Pyrenaicus, 8000′.
Anemone baldensis, 4500′.
Aconitum Anthora, 4500′.
Napellus, 6500′.
Stoerkianum, 6500′.
Arabis cærulea, 7000′.
Hutchinsia alpina, 7000′.
Hutchinsia rotundifolia, 7000′.
Papaver pyrenaicum, 5500′.
Viola biflora, 3500′.
Silene acaulis, 5500′.
pumilio, 7000′.
Cerastium latifolium, 6500′.
Cytisus alpinus, 1300′.
purpureus, 2000′.
Trifolium alpinum, 5500′.
Phaca astragalina, 6500′.

Phaca alpina, 6500′.
Hedysarum obscurum, 7000′.
Dryas octopetala, 2000′.
Potentilla caulescens, 1300′.
nitida, 6500′.
Geum montanum, 5500′.
reptans, 8000′.
Sibbaldia procumbens, 5500′.
Rosa alpina, 5500′.
Sedum atratum, 7000′.
Rhodiola rosea, 7000′.
Saxifraga Aizoon, 1300′.
aizoides, 1500′.
cæsia, 1500′.
rotundifolia, 2000′.
mutata, 2500′.
Burseriana, 2500′.
cuneifolia, 3500′.
stellaris, 5500′.
aspera, 5500′.
controversa, 6500′.
muscoides, 6500′.
planifolia, 7000′.
androsacea, 7000′.
sedoides, 7000′.
bryoides, 7000.
oppositifolia, 8000′.
Bupleurum graminifolium, 6500′.
Lonicera nigra, 4500′.
'alpigena,' 4500′.
Valeriana saxatilis, 1300′.
Aster alpinus, 1500′.
Tussilago alpina, 2000′.
Cacalia alpina, 4500′.
Arnica montana, 2000′.
Bellidiastrum, 1300′.
Gnaphalium Leontopodium, 1500′.
Chrysanthemum alpinum, 7000′.
Anthemis alpina, 6500′.
Achillæa Clavennae, 4500′.
moschata, 7000′.
Doronicum scorpioides, 7000′.
Aronicum Clusii, 7000′.
Senecio abrotanifolius, 5500′.
carniolicus, 7000′.
Cirsium ochroleucum, 2500′.
spinosissimum, 5500′.
Carduus defloratus, 5500′.
Saussurea alpina, 7000′.
Sonchus alpinus, 4500′.
Phyteuma comosum, 1300′.
Scheuchzeri, 1300′.
hemisphæricum, 5500′.
orbiculare, 5500′.
Sieberi, 7000′.
pauciflorum, 7000′.
Campanula barbata. 4500′.
Morettiana, 4500′.
Rhododendron hirsutum, 1300′.
Chamæcistus, 1300′.
Arbutus uva ursi, 2500′.
alpina, 5500′.
Azalea procumbens, 7000′.
Vaccinium Myrtillus, 2000′.
Vitis idæa, 2000′.
Primula Allionii, 2500′.
glutinosa, 7000′.
minima, 7000′.
longiflora, 6500′.
Auricula, 6500′.
Soldanella alpina, 2500′.
minima, 2500′.
Cortusa Matthioli, 7000′.
Androsace alpina, 7000′.
obtusifolia, 7000′.
Aretia Vitaliana, 8000′.
Pinguicula alpina, 2000′.
grandiflora, 2000′.
Gentiana acaulis, 1300′.
germanica, 1300′.
utriculosa, 2000′.
cruciata, 3500′.
asclepiadea, 3500′.
ciliata, 3500′.
punctata, 5500′.
bavarica, 5500′.

Gentiana nivalis, 5500′.
pumila, 5500′.
Linaria alpina, 1300′.
Euphrasia tricuspidata, 1300′.
Salisburgensis, 1500′.
Pedicularis tuberosa, 4500′.
rostrata, 6500′.
verticillata, 6500′.
rosea, 6500′.
Bartsia alpina, 6500′.
Pæderota Bonarota, 1500′.
Veronica alpina, 4500′.
aphylla, 4500′.
Horminum pyrenaicum, 1300′.
Betonica Alopecuros, 1300′.
Myosotis nana, 8000′.
Globularia nudicaulis, 1300′.
cordifolia, 1300′.
Daphne striata, 1500′.
Pinus Pumilio, 1400′. Between Agordo and Peron.
Nigritella angustifolia, 4500′.
Himantoglossum viride, 4500′.
Crocus vernus, 2000′.
Czackia Liliastrum, 2500′.
Luzula nivea, 5500′.
Carex atrata, 5500′.
firma, 5500′.

Giacich has enumerated the rare plants of Monte Maggiore, in Istria (Ratisbon Flora, 1844, pp. 274-6). Hauffel gives a sketch of the Carices of Hungary, Croatia, Slavonia, and Siebenbürgen (Id. pp. 527-36). The author here again refers his *C. rhynchocarpa* to *C. brevicollis* Lam., and regards *C. saxatilis* Baumg. as *C. dacica*.

Moritzi has written a new Manual of the Swiss Flora (Die Flora der Schweiz. Zurich, 1844-8). Trog has published a Catalogue of Swiss Fungi (Berner Mittheilungen, pp. 17-92), in which 1121 species are mentioned.

The upper limit at which the larch occurs on the south side of the Mont Blanc chain at Cramont, in Courmayeur, was found by the measurement of Forbes, to be 7200′ Engl.; and on the north side, on the rocks les Echellets which belong to the Mer de Glace, 6800′. (Travels through the Alps of Savoy. Edinb., 1843, pp. 68 and 215.)

The seventh and eighth centuries of F. Schultz's 'Flora Galliæ et Germaniæ exsiccata' have been issued, and are accompanied by critical remarks upon individual plants (see Bot. Zeitung, 1845). By the same author, four French plants are proposed as new in the 'Ratisbon Flora' (1844, pp. 806-9); *Orobanche brachysepala* Sch. according to the description given, and comparison with the

original plants, is identical with *O. apiculata* Wallr. Rchb. (Spicil. rum., 2, p. 58); *O. macrosepala* is probably my *O. Bartlingii*, a name which obtained priority by several months.

French local Floras: J. Lloyd, 'Flora de la Loire inférieure' (Nantes, 1844, 12); Guépin, 'Supplément à la Flore de Maine et Loire' (Angers, 1842).

Martins has worked out an exposition of the climatal contrasts which occur within the boundaries of France (les Régions Climatoriales de la France), in the 'Bibliothèque de Genève, 1844, pp. 138-60, and pp. 347-50. The author distinguishes the five following climates in France.

1. *Climate of the Vosges.* This comprises a district in the north-east of France, which is bounded by the cities of Basle, Dijon, Auxerre, and Mezières. Mean temperature = 9° 6 C. The relatively most intense winters predominate in this region, the difference between the mean summer and winter heat amounts to 18° C. (18° 6 and 0° 6 C.); the greatest cold observed in Strasburg and Metz amounted to about 23° C. The mean quantity of rain (from meteorological observations made at Strasburg, Mühlhausen, Nancy, Metz, and Geneva) = 669 mm.; of this, 19 p. c. fall in the winter, 23 in the spring, 31 in the summer, and 27 in the autumn. Average number of rainy days = 137. Predominant winds, those from the south-west and north-east.

2. *Climate of the Seine,* or north-west of France, as far as the Loire and Cher. Mean temperature 10° 9 C. Difference between the mean summer- and winter-temperature = 13° 6 C.; diminishing in the direction from Brussels (=14° 3 C.) to Brest (= 10° 8 C.); the former average value is the arithmetical mean of observations made at Dunkirk, Arras, Abbeville, Paris, Cherbourg, Angers, and Denainvilliers. Average amount of rain = 548mm.; in Finisterre, however, it amounts to 900mm. (from observations made at Paris, Brussels, and Denainvilliers, 21 p. c. of the rain falls in winter, 22 in spring, 30

in summer, and 27 in the autumn. Average number of rainy days = 140. The prevailing wind is the south-west, the next is the north-east.

3. *Climate of Garonne,* or south-west of France, as far as the Pyrenees. The eastern boundary is situated in Auvergne, but cannot at present be accurately defined; it probably includes the plateau of Auvergne, and follows the course of the Rhone and Saône. Mean temperature = 12° 7 C. Difference between summer- and winter-heat = 160° C.; on account of the smaller extent of the coast-line, the marine climate is less developed here than in the north-west; mean summer-temperature = 20° 6 C., winter-temperature = 5° C. Greatest intensity of cold at Poitiers, La Rochelle, Toulouse, and Agen, where it attains to —12° C. Average amount of rain = 586 mm.; of which, 25 p. c. fall in winter, 21 in spring, 23 in summer, and 34 in autumn. Average number of rainy days = 130. The prevailing wind is the south-west, which in the neighbourhood of the Pyrenees passes into the west.

4. *Climate of the Rhone,* comprises the valley of the Rhone, from Dijon and Besançon to Viviers, and the mountainous regions of the Higher Alps; the boundary in the department of the Lower Alps is at present undefined. Mean temperature = 11° C. Difference between summer and winter = 18° 6 C. Mean temperature of summer = 21° 3 C., of winter 2° 5 C. Average quantity of rain = 946 mm., i. e. the greatest amount precipitated throughout the whole of France; of which 20 p. c. falls in the winter, 24 in the spring, 23 in the summer, and 34 in the autumn. Number of rainy days in the valley of the Saône = 120-30, in the valley of the Rhone = 100-15. Prevailing winds, north and south.

5. *Mediterranean climate.* The northern boundary runs through the Rhone at Viviers, near Montélimart, thence follows a line drawn on one side to Montpellier, on the other to Marseilles, and, lastly, comprises the coast-districts of Provence and the regions of Aude as far as

the Pyrenees. Mean temperature = 14° 8 C. Mean summer temperature = 22° 6 C., and winter temperature = 6° 5C. Greatest intensity of cold observed — 11° 5 C. Average amount of rain = 651 mm.; of which 25 p. c. fall in the winter, 24 in the spring, 11 in the summer, and 41 in the autumn. Prevailing wind, north-west. —(Mistral.)

A work by Grenier, relating to the botanical conditions of the French Jura, appears of importance; at present, however, I am only acquainted with it from Von Schlechtendal's review (Thèse de Géographie Botanique du Dép. de Doubs, Strasbourg, 1844-8). According to this work, the upper limit of the oak here occurs at an altitude of 6-700 metres, that of the beech at 8-900 metres; above these deciduous trees comes the Coniferous region, covered with both kinds of fir-trees.

Lloyd's Flora of the Mouth of the Loire also notices the local conditions of vegetation. The diffusion of several plants belonging to the south of Europe, along the sea-beach, as far as the 47th degree of latitude, is characteristic: e. g. on the lagunes, *Inula crithmoides*, *Sonchus maritimus*, several *Statices*, *Salicornia fruticosa*, *Scirpus Savii*, *Spartina stricta*; on the downs, *Matthiola sinuata*, *Silene portensis*, *Tribulus terrestris*, *Otanthus maritimus*, *Ephedra distachya*, *Pancratium maritimum*, &c. But on the heaths of Bretagne are also found *Erica ciliaris*, *vagans*, and *scoparia*, *Simethis bicolor* Kth. (*Phalangium* D. C.), *Asphodelus albus*, *Pinguicula Lusitanica*, *Serapias triloba*, in conjunction with northern plants, as *Ulex Europæus*, *Narthecium ossifragum*, *Anagallis tenella*, *Hypericum elodes*, *Myrica Gale*, and *Alisma ranunculoides*.

To this place belong, on the French coast of the Mediterranean, the investigations of Duchartre upon the vegetation of the district around Béziers in the Dép. Hérault (Comptes rendus, 1844, v, 18, pp. 254-9). This work gives an accurate and complete survey of the vegetable formations which occur there. The author divides

them into two principal classes, according as their growth is consequent on proximity of the sea or not.

1. The following formations belong to the coast-plants: *a. Formation* of the *Dunes.*—Herbs or low shrubs, which are either of very pubescent or of glaucescent tint. To the former belong, e. g. *Matthiola sinuata, Medicago marina, Orlaya maritima, Mercurialis tomentosa. Diotis candidissima;* to the latter, *Eryngium maritimum, Echinophora, Euphorbia Paralias,* and *Crucianella maritima.* The shrubby plants consist of *Astragalus massiliensis* and *Ephedra distachya.* As regards the number of forms, the Grasses predominate (12 species are known), the Cruciferæ come next, with 4 species, the Leguminosæ and Euphorbiaceæ number 3 species, and the Chenopodeaceæ, Polygonaceæ, and Synantheraceæ: altogether more than 40 species grow there. Among the dunes 2 allied species of *Juncus* are found (*J. acutus* and *maritimus*), a formation peculiar to the humid soil, which in the Landes is denominated Joncasses, and forms the transition to the following formation.

b. Formation of the Salt-water Marshes.—Shrubs and herbaceous perennials, with succulent leaves. Chenopodeæ and Statices predominate here, both as regards the number of individuals and of species: among woody plants, *Tamarix Gallica* is found arborescent. Characteristic forms among the Chenopodeaceæ (11 sp.): *Chenopodium fruticosum, Ch. setigerum, Salicornia,* 3 sp., *Salsola,* 2 sp., *Atriplex,* 3 sp.; of the Statices (5 and more species) *St. oleifolia, bellidifolia,* and *ferulacea;* of other plants (15 sp.), *Frankenia,* 2 sp., *Spergularia,* 2 sp., and *Artemisia Gallica.* The Graminaceæ are here represented by *Crypsis schœnoides* only.

2. The plants independent of the influence of the sea, resolve themselves into formations of a moist and dry soil; the latter are either independent of the cultivation of the land or not so.

A. Water-plants.

a. *Fresh-water Formati*
minaceæ, Cyperaceæ and
and Typheæ, it possesses b
teristic of the climate; as,
Marsilea pubescens, Ten.

b. *Formation of those*
overflowed, are characteris
These are the localities of
sicula.

B. Plants of the uncultiv
author believes that three
tinguished, of which the
more distinct than the rest

a. *Garrigues*, i. e. *Forn*
soil is densely covered wi
other firmly interlaced and
shrubby forms are the foll
folius, *albidus*, and *monspel*
Europæus; *Daphne Gnidiu*
scoparia and *cinerea*, *Callu*
tifolia and *latifolia*; *Lav*
Juniperus Oxycedrus and *co*
cinalis. Among other pla
teristic: a number of speci
with the *Cisti*, some *Euph*
Stæchas, *Aphyllanthes*, &c.
more than 40 species are e

b. Duchartre has not bee
liarities of those surfaces
covered with shrubs and a
according to their charact
shall, therefore, pass over t
merely mention some of t
belong here: *Biscutella cor*
Centaurea Pouzini, and *Ec*

C. Plants of the cultivate

a. *Formation of the rude*
all widely diffused.

b. Plants accompanying those which are cultivated. The author makes several divisions of these, which it is not necessary to detail. The number of species enumerated is very considerable, but they are not characteristic of the south of France, as distinguished from other countries on the Mediterranean.

c. Formation of the meadow-lands. The same remark applies to this: *Euphorbia pilosa* and *Iris spuria*, however, deserve to be mentioned.

d. Formation of the forests. The evergreen forests consist of *Quercus Ilex:* there are no others. Underwood: *Pistacia Lentiscus* and *Terebinthus*, *Erica arborea* and *Calluna*, *Sarothamnus scoparius*, *Cytisus capitatus*, *Genista Scorpius*, *Spartium junceum*, &c.

From the appended sketch of the cultivated plants, it is seen that the preparation of soda from Halophytes has entirely ceased in that district, that the cultivation of the olive is very much on the decrease, in consequence of several cold winters having destroyed the plantations, and that latterly attempts have been made to cultivate *Ricinus* on a large scale. The principal production of Béziers is wine; the cerealia do not suffice for home consumption.

Desmoulins has given a description of his botanical journey in the Pyrenees, during which he made some observations upon the vertical limits of the Alpine flora of the Pic du Midi (Etat de la Végétation sur le Pic du Midi de Bigorre. Bordeaux, 1844, 8vo.) We extract from it the following additions to the earlier statements of De Candolle and Ramond:

Cochlearia pyrenaica, 5500′—6000′.
Herniaria pyrenaica, 3000′—7500′.
Paronychia polygonifolia, 6000′—7500′.
— *serpyllifolia*, 7500′—8400′.
Astragalus depressus, 6000′—7500′.
Vicia pyrenaica, —8500′.
Carduus carlinoides, 6000′—8100′.
— *carlinifolius*, 3000′—6900′.
Cirsium eriophorum, 0′—6600′.
Scabiosa pyrenaica, —8400′.

Pedicularis pyrenaica, —9000′.
Crocus nudiflorus, —7500′.
Anictangium ciliatum, —8400′.
Parmelia chrysoleuca, 6400′—9000′.
— *cartilaginea, elegans, cinerea, bad*
Lecidea vesicularis biformis, 6000′—7500′.
— *polycarpa, atrobrunnea, morio, geog*
Umbilicaria cylindrica, 6000′—9000′.

Some interesting letters, wri
during a journey in Spain, have be
tanische Zeitung' (1844-5). They
bearing date from Valencia, whe
until the middle of June. He
botanised at Aranjuez in the be
over the Sierra Morena, reached
the latter part of the summer an
the Sierra Nevada and the Alpu
report, we shall confine ourselve
journey, intending to recur to th
south of Spain next year, when th
illustrated work, together with V
of 1845, will conjointly furnish
tion of that part of the subject.
lencia, the original vegetation i
cultivation: wheat, rice, and her
vated; mulberry trees, olives, and
south are common, date-palms
high, are frequently met with.
is a wood of *Pinus Halepensis*,
the original plants of this distric
consists of *Quercus coccifera*, *M*
and growing with them we fi
Rhamnus lycioides, *Erica arborea*
Oxycedrus, and *Ruscus aculeatu*
hills contain *Cistus albidus* and
hirsuta and *Solanum sodomeum*,
of the thickness of the arm.

The Sierra de Chiva, 12 miles n
to the limestone mountains, wh

Spanish plateau, between the Ebro and Xucar, traverse the province from west to east as far as the sea. This broad mountain-range, which is about 6000′ in height, and intersected with deep Barrancos, was once covered with forests of Coniferæ, the only remains of which at the present time are isolated stems of *Pinus Halepensis*. The dry slopes, which are almost entirely free from springs, are now overgrown with a low bush (Montebaxo), the extreme summits only being bare. Willkomm admits the following stages in the Mediterranean vegetation of this region, which attains an unusual elevation, ascending to 4000′.

0—500′. To about this height the Opuntias and Agaves extend, together with the culture of *Ceratonia*. The Montebaxo consists of *Chamærops*, *Erica arborea*, *Daphne Gnidium*, *Retama sphærocarpa*, *Ulex*, *Rosmarinus*, and some oaks.

500′—2000′, i. e. as far as the upper limits of *Chamærops* (also of *Retama*, *Juniperus Oxycedrus*, and *Pistacia Lentiscus*). *Rosmarinus* and *Chamærops* predominate; in addition to those already mentioned, *Erica arborea* from among those of the first stage, and *Rhamnus lycioides*, *Pistachia Terebinthus*, and some *Cisti* are here first met with. Characteristic Grasses: *Macrochloa tenacissima* and *Stipa juncea*.

2000′—4000′ up to the limits of the cultivation of the olive and wheat. The greater part, however, of the slopes at this level consists of uncultivated mountain-land. In a Montebaxo, the principal plants associated here with *Rhamnus*, *Rosmarinus*, *Erica*, and *Cisti*, are *Juniperus Phœnicea*, *Fraxinus* sp., *Arbutus unedo*, and *Quercus Ilex*.

Isolated pine-trees and a Montebaxo formed of *Ulex Australis* and *Juniperus Phœnicea* characterise the region extending from 4000′—5500′, which may be distinguished from the Mediterranean by the occurrence of the plants of the north of Europe. On the summit of the Monte de la S. Maria (5500′—6000′), of woody plants, *Arctostaphylos uva ursi*, *Taxus*, and some Cotoneasters

are also found; and with them few shrubs only and a single species of Saxifrage.

V. Martens, in a general work, has described the botanical geography of Italy from literary sources (Italy, Stuttgard, 1844, 8vo, 3 vols.)

Works upon the Flora of Italy. The first two parts of the sixth vol. of Bertolini's Flora Italica, which treat of the 14th class, have appeared (Bologna, 8vo.) The Flora of Nice, by A. Risso (Nice, 1844, 8vo), is of no scientific value. We have not yet received Cesati's paper upon that of Lombardy (Saggio sulla Geographica botanica e sulla Flora della Lombardia. Milano, 1844, 8vo, p. 74). Purcinelli Additamentum ad synopsin plantarum in agro Luccensi sponte nascentium (in the Giornale Botanico Italiano. 1844, pp. 118-123). Savi Florula Gorgonica (id. pp. 243-283), a catalogue enumerating 290 sp. of vascular plants observed in Gorgona, a small island opposite Leghorn, and covered with *Cisti*, *Ericas*, and Leguminous shrubs, may be considered as a companion to the Flora of Capraja, published some years ago by Moris and Notaris. De Notaris, Appendix to his Specimen Algologiæ Ligusticæ (id. pp. 191, 311). Meneghini, Algarum species novæ vel minus notæ (id. pp. 296-306), 33 species from the coasts of Italy and Dalmatia. The fourth part of Alghe Italiane e Dalmatiche, by the same author, has appeared (Padova, 1843, 8vo). Tenore has shown that the Dalmatian *Arenaria Arduini* is identical with his former *A. Rosani* (Rendic. Acad. 1842, p. 266). V. Heldreich describes four new Sicilian plants (Ratisbon Flora, 1844, p. 65): 1 *Helianthemum*, 1 *Elichrysum*, 1 *Centaurea*, and 1 *Lithospermum*. Nyman's Observationes in Floram Siculam (Linnæa, 1844, pp. 625-665) contain a catalogue of his collection which is for sale in Sweden, with descriptive remarks. The only new plant is *Parietaria populifolia*, N. from Malta.

Link distinguishes a new *Erica anthura*, obtained from Spalatro (Sitz. des Ges. naturf. Freunde, 1844, in the Ratisbon Flora, 1845). Visiani raises *Turinea Neu-*

mayerina Vis., which was figured, in the Flora Dalmatica, into a separate genus as *Amphoricarpos* (Giorn. Bot. It., vol. i, p. 196).

Ebel's essay on Montenegro (Zwölf Tage auf Montenegro, Hft. 2. Königsberg, 1844, 8vo), contains a catalogue of all the Phanerogamous plants hitherto observed in Dalmatia (2003 sp.), with a statement of the frequency of their occurrence, expressed in a manner peculiar to the author, but the localities are not given. It contains preliminary observations upon the statistical relations of the flora of Dalmatia, in which the most abundant families form the following series, according to the number of species contained in them: Synantheraceæ (225 sp.), Leguminosæ (220 sp.), Graminaceæ (142 sp.), Cruciferæ (107 sp.), Umbelliferæ (103 sp.), Labiatæ (91 sp.), Caryophyllaceæ (85 sp.), Scrophulariaceæ (82 sp.), Liliaceæ (61 sp.), Rosaceæ (59 sp.), Ranunculaceæ (54 sp.), Orchidaceæ (46 sp.), Cyperaceæ (43 sp.), Boraginaceæ (42 sp.) The reports upon the vegetation of Montenegro itself, the productions of which, according to the author, entirely agree with those of Dalmatia, belong here. This small tract of land, which is covered with arid, rocky mountain-pastures, and elevated into limestone summits, which are either barren or slightly surrounded with forests of pines, and from which narrow fluviatile valleys descend to the sea of Scutari, is extremely unfruitful from a deficiency of soil and water. Nevertheless, the plants appear, as in Dalmatia, to be various, 450 sp. having already been mentioned by the author: there are no new ones among them, the two which are proposed as new are untenable.

In my work upon Rumelia and Bithynia (Spicilegium Floræ Rumelicæ et Bithynicæ, exhibens synopsin plantarum, quas anno 1839 legi: accedunt species, quas in iisdem terris lectas communicarunt Friedrichsthal, Friwaldzki, Pestalozza vel plene descriptas reliquerunt Buxbaum, Forskal, Sibthorp, alii; vols. i, ii, Brunsnigæ, 1843-4, 8vo), 2300 Phanerogamous plants are treated of systematically, and in regard to their geographical dis-

tribution. The families containing most species form the following series: Synantheraceæ (264 sp.), Leguminosæ (203 sp.), Graminaceæ (156 sp.), Labiatæ (134 sp.), Caryophyllaceæ (130 sp.), Cruciferæ (121 sp.), Umbelliferæ (114 sp.), Scrophulariaceæ (90 sp.), Ranunculaceæ (78 sp.), Rosaceæ (68 sp.), Boraginaceæ (55 sp.), Liliaceæ (53 sp.), Rubiaceæ (48 sp.), Campanulaceæ (41 sp.), Orchidaceæ (41 sp.), Cyperaceæ (41 sp.) When this series is compared with that given above for Dalmatia, the increase in the Labiatæ and Caryophyllaceæ becomes one of the characteristic peculiarities of Rumelia. The former family does not reach the centre of its distribution through the south of Europe until we arrive at Greece; but the Silenaceæ, which abound in endemic forms of *Dianthus* and *Silene*, do not appear to be anywhere more numerous than in Rumelia. The increase in the Ranunculaceæ, Boraginaceæ, and Campanulaceæ is also worthy of consideration; but I must confine the deductions to these few facts, since if carried further than the extent of our present knowledge admits, they would lose in truth. The extent of our knowledge of the flora of Rumelia is much better shown by the examination of those vegetable forms which are endemic to that country, than by sketches of the entire vegetation, in which so many constituents are still wanting. Of these 2300 species of plants, about the seventh part are peculiar to the peninsula of Europe: from these about 80, which have only been found in Bithynia, are excluded, a great part of which, however, will probably be found also on this side of the Bosphorus. Moreover, if we take into account the distribution of Greek plants over the south, and of Dalmatian over the west of Rumelia, we may consider more than two thirds of the endemic plants of the south-east of Europe as known. *Summary of the endemic plants of Rumelia:* 23 Leguminosæ, principally species of *Trifolium* (5), and *Astragalus* (9), mostly belonging to the evergreen region; 5 Rosaceæ, of these, 3 Dryadeæ to the mountainous region; 2 Rutaceæ (*Haplophyllum*); 4 Euphorbias, of which

2 belong to the alpine region; 2 Geraniaceæ to the alpine region; 25 Caryophyllaceæ, especially species of *Silene* (6), and *Dianthus* (10), only 5 Alsineæ: species from all three regions, but the pinks mostly indigenous to the central European and alpine; 5 Hypericineæ (*Hypericum*) from the evergreen region; 14 Cruciferæ, one half of which consist of alpine species of *Arabis, Cardamine, Koniga, Thlaspi,* and *Eunomia;* 15 Ranunculaceæ, with 7 species of *Ranunculus,* mostly from the evergreen region; 2 Crassulaceæ; 3 Saxifrages from the alpine region; 21 Umbelliferæ, increasing towards the coast; 2 Ericaceæ: *Erica verticillata* and *Arbutus Andrachnus;* 3 Primulaceæ; 26 Scrophulariaceæ, principally alpine *Pediculares* (3), species of *Veronica* (4), *Digitalis* (3), *Scrophularia* (4), and *Verbasca* of the evergreen region (8); 2 *Orobanches;* 9 Boraginaceæ, among these 4 species of *Alkanna,* 2 of *Borago;* 20 Labiatæ, of these 6 species of *Stachys* in both the lower regions; 9 Rubiaceæ in the evergreen and alpine region (instead of the term *Galium trichophorum,* which was elsewhere proposed at the same time, I prefer that of *G. Trichodes*); 2 Valerianaceæ; 9 Dipsaceæ; 40 Synantheraceæ, principally Anthemideæ and Cynareæ, mostly from the genera *Anthemis* (6: mostly in the evergreen region), *Achillea* (5: mostly in the alpine region), *Senecio* (4), *Centaurea* (5), *Cirsium* (5); 13 Campanulaceæ, of which 10 were *Campanulæ,* most of which belonged to the evergreen region; 2 Amentaceæ: *Quercus Ægilops* and *infectoria;* 3 Coniferæ: *Pinus maritima* in the lower, *Juniperus sabinioides* in the middle, and *Pinus Peuce* on the boundary of the alpine region; 3 Orchidaceæ; 4 Iridaceæ, species of *Crocus* in the evergreen region; 12 Liliaceæ, e. g. *Ornithogalum* (3); 2 Cyperaceæ; 11 Graminaceæ from all three regions. The remaining endemic plants are as yet single members of their families: the Bithynian, &c. Of the Cryptogamia, we are not yet acquainted with 200 species.

Heldreich observed at Athens a form of *Arbutus,* which was probably *A. hybrida* Ker., but is regarded by him as

a distinct species, intermediate between *A. Unedo* and *Andrachne* (Ratisbon Flora, 1844, p. 13). He denies its hybrid origin, because *A. Unedo* flowers in October and November, *A. Andrachne* in February and March; I have, however, met with both plants in flower at the same time in Bythynia.

II.—ASIA.

Among the endemic plants of Bithynia described in the 'Spicileg. Rumelic.,' part of which belong to the evergreen coast-region, part to the high mountains of Olympus and Bolu, the following are the principal families represented: 5 Leguminosæ (mostly *Trifolia*); 2 Geraniaceæ; 5 Caryophyllaceæ (consisting of 3 Sileneæ and 2 *Dianthi*, all from Olympus); 4 *Hyperica*, 9 Cruciferæ (all from Olympus, and consisting of 3 sp. of *Arabis*, 2 sp. *Eunomia*, &c.); 3 Papaveraceæ; 2 Ranunculaceæ; 5 Umbelliferæ (mostly from Olympus); 4 Scrophulariaceæ; 2 Boraginaceæ; 3 Labiatæ; 3 Rubiaceæ; 13 Synantheraceæ; 4 Campanulaceæ; 3 Liliaceæ; 3 Graminaceæ, &c.

The oriental Umbelliferæ have been worked out by Boissier (Ann. Sc. Nat. 1844), comprising 300 species. The number of species proposed as new is very large. The new genera distinguished are the following: *Lereschia* (*Cryptotænia Thomasii* D. C.); *Elwendia*, from Persia, near *Carum; Microsciadium* (*Cyminum minutum* Urv.); *Muretia* (*Bunium* sect. *Chryseis* D. C.); *Diplotænia* from Persia, near *Peucedanum; Stenotænia* from the same place, near *Pastinaca; Ducrosia* (*Zozimiæ*, sp. D. C.); *Ainsworthia* (*Hasselquistia cordata* L.); *Trigonosciadium* from Mesopotamia, near *Heracleum; Synelcosciadium* (*Heracl. Carmeli* Lab.); *Polylophium*, (Thapsieæ) from Persia; *Smyrniopsis* near *Smyrnium; Meliocarpus* near *Prangos; Turgeniopsis* (*Turgenia fœniculacea* Fzl.); *Lisæa*

(*Turgeniæ*, sp. D. C.); *Rhabdosciadium*, one of the Scandicineæ from Persia; *Thecocarpus*, from the same place and from the same division; *Osmosciadium*, one of the Coriandreæ, from Cappadocia.

C. Koch's travels to the Caucasus (Reise durch Russland nach dem Kaukasischen Isthmus in den J. 1836-8. Bd. i, ii. Stuttgard, 1842-3) contains reports upon the autumnal vegetation of Ossetia and Imiretia, as also upon the vernal flora of Russian Armenia; the author's investigations were subsequently interrupted by protracted illness, but he finally resumed them in a second journey. In the military road of the Caucasus, Koch represents the prairies of Kabarda, near Uruch, as very luxuriant and abundant in plants; herbs and the Grasses grow here in such luxuriance, that a man can readily conceal himself without lying down (i, p. 250). The Graminaceæ are mostly the same as the meadow-grasses of central Europe, whilst among the shrubs many Caucasian species are mèt with; they are diffused by the rivers over these surfaces which are situated opposite to the high mountain chain. By this circumstance and the development of the vegetation in the height of summer, when the Russian heaths are burnt up, the meadows of Kabarda differ essentially from the steppes, with which C. Koch has compared them. In fact, judging from certain kinds of plants, the steppe climate still prevails here; this is shown by the Artemisiæ, Cynaraceæ, and Astragalaceæ; but the influence of the neighbouring mountains modifies the character of the vegetation as determined by the climate. The plants of the steppes are destroyed in the summer by the drought, whilst Kabarda is well watered from the Caucasus.

C. Koch remained during October in Ossetia, in the middle of the high Caucasus, and the offsets connecting it towards the south with the Armenian highlands, and then travelled in Imiretia until the end of the year, certainly too late a period to allow of the botanical character of the country being completely ascertained. The reports

are partly limited to lists of the localities of the autumnal plants which he was then able to collect. The alpine flora, even at elevations of 7—8000′ was but slightly represented by its characteristic forms (ii, p. 69); these high mountains are altogether more sterile than the Alps, which the author attributes primarily to the rarity of glaciers in the Caucasus, as if the alpine meadows of the Tyrol were only fertilized by melting ice. He then goes so far as to assert (p. 91), that the disintegrated soil of Ossetia, the steep rocks and precipitous defiles, of this alpine district, are not adapted to the production of humus, and that this is the cause of the total absence of a luxuriant vegetation there. But the author is not clear upon this point, and does not separate general from local conditions; for he speaks at the same time of clay-slate plateaux, but little supplied with water and destitute of woods, extending between the defiles and valleys to the ridge and lateral offsets of the Caucasus. Upon this form of mountain and peculiarity of soil the alpine poverty of Ossetia appears to depend; that it also prevails over the well-wooded slopes of the northern Caucasus is not probable. But Ossetia shares this deficiency of alpine vegetable forms with the mountains of the south of Europe, where alpine pastures abounding in species are but rarely developed, and where this phenomenon is occasioned by the deficiency of water upon narrow crests and summits. Ossetia does not possess the fine forests of the northern promontories of the Caucasus. Even in the true forest region there is a perceptible deficiency of wood, and frequently the soil is scarcely covered with a scanty underwood: e. g. at Zrchinwall (p. 55) consisting of *Corylus*, *Cornus mascula*, *Paliurus*, *Cratægus*, *Prunus insititia*, and *Juniperus*. The traveller only met with wooded slopes at Dschedschora, in the district of Gudaro, (p. 82); here deciduous trees predominated, and the Coniferæ present were *Pinus abies*, *picea*, and *orientalis*, *Taxus*, and *Juniperus communis*. The deciduous forests consisted of the oak, beech, maple, lime, and alder (*Quercus*

iberica Stev. and *Robur* (?), *Carpinus orientalis, Fagus, Acer platanoides, Tilia parvifolia, Alnus denticulata* C. A. M.); the underwood of *Euonymus latifolius, Rhamnus frangula* and *cathartica, Staphylea pinnata, Viburnum orientale, Argyrolobium lotoides,* and *Lonicera cærulea.*

The Imiretian slopes of the Caucasus in the upper valley of Rion (p. 129) are more abundantly wooded; above the vine mountains of the latter, mixed forests of deciduous trees ascend to a considerable height; in addition to the trees above mentioned, the chesnut, various fruit trees, and poplars were found at Oni, as also among the shrubs, *Ilex, Azalea pontica,* and *Rhododendron Caucasicum, Rhus Cotinus,* together with *Smilax excelsa.* At Glola, wild fruit-trees, especially *Pyrus communis,* and *Prunus avium,* extended to beyond 5000′. A region of subalpine shrubs, of which *Arctostaphylos* and *Azalea pontica* ascend together high up at the glacier of Rion, immediately succeeds the deciduous forests; and with them, subalpine herbaceous perennials, as *Aconitum nasutum* Fisch., *Pyrethrum macrophyllum, Doronicum Caucasicum,* &c. Lower down in the valley of Rion, Koch describes a fine primitive forest at Kutais (p. 166), consisting of magnificent trunks of *Carpinus orientalis,* oaks, and high tops of the chesnut and plane-trees projected singly; in thickets, luxuriant lianes of the grape-vine, *Smilax,* and ivy, upon the branches of which the mistletoe grew, and from which *Usneæ* were suspended.

The journey from Tiflis to Eriwan through Georgia and Russian Armenia was made during the months of April and May, in 1837, and yielded a rich booty. The forests of Somchetien differ from those of Imiretia, in the more regular growth of the trees, and in the absence of evergreen shrubs and lianes (p. 350). They consist of *Quercus iberica* and *pedunculata, Carpinus Betulus* and *orientalis, Acer platanoides* and *pseudoplatanus;* with isolated examples of *Ulmus excelsa* Bork., *Fagus,* and *Acer tartaricum.* The soil of these forests consists of a thick layer of humus, and this black earth produces the

beautiful mountain pastures which alternate with the former. The traveller soon ascended the high mountain chain between Kur and Araxes, forming the boundary between Georgia and Armenia (this he calls the lower Caucasus, Güldenstedt and Klaproth call it the promontory of Ararat), which, according to Parrot's measurement, ascends to an elevation of 12,780′. But vegetation was still backward in this region, for even in the Armenian highlands, few of the herbaceous plants and Grasses which, with a thorny underwood of Tragacanth, cover the bare heights, were in flower (p. 386). However, on going from Alagäs, near the valley of Araxes, to Eriwan, Koch was amply compensated by the banks of the Kasach (p. 397). The climate is so dry, that even in May the soil is parched and barren, whilst in the more elevated regions vegetation has scarcely commenced. But by artificial irrigation, the cultivation of the soil may be effected even during the hot and dry months, the fields and orchards surrounding the villages then resemble oases in a stony desert. Fruit trees were planted generally, especially peach trees and apricots; besides these there was a natural arboreal vegetation along the Kasach valley, consisting of *Elæagnus* and *Populus*, with *Prunus incana*, and *Tamarix*. In Eriwan, especially, the greatest attention is paid to the cultivation of fruits and the vine, and the traveller had never met with more beautiful gardens than he saw there.

Schrenck continued his travels in Soongarei in 1843, and has already made known the plants he found in that year (Bulletin Pétersbourg, iii, pp. 106-10, 209-12, 305-9). They belong to the following genera: *Ranunculus* (2 sp.), *Stubendorfia*, nov. gen. Crucifer., *Isatis*, *Geranium*, *Zygophyllum*, *Haplophyllum*, *Euphorbia* (2 sp.), *Sophora*, *Oxytropis*, *Astragalus*, *Seseli*, *Lomatopodium*, nov. gen. Umbelliferæ, *Carum*, *Artemisia* (2 sp.), *Chamægeron* near *Henricea*, *Saussurea*, *Cousinea* (4 sp.), *Plagiobasis*, nov. gen. near the preceding, *Jurinea*, *Serratula*, *Echinops*, *Echinospermum*, *Eremostachys*, *Arthrophytum*, nov. gen.

Chenopod., *Pterococcus*, *Statice*, *Populus*, *Ephedra*, *Allium*, *Typha*, and *Triticum* (2 sp.)

Middendorf has commenced the arrangement of the results of his journey through the north of Siberia, which was mentioned in the preceding annual report (Bulletin Pétersbourg, iii, pp. 150 et seq.) The Tundres of the Taimyr country, i. e. the peninsula situated between the lower Jenisei and the Katanga, contain in their diluvial loam, in addition to the mammalia of the diluvium, large masses of wood either in a bituminous state, such as is found in the peat moors, or converted into peat. In such of these tracts, however, as were beyond the tree limit, the stems were only met with lying horizontally, and were compared by Middendorf to the floating timber of the arctic coast, and from which, by the rising of the land, they may have gradually attained the interior. The trees appear to be of the same kinds as those in the forests of New Siberia and the fluviatile valleys of Siberia, consisting principally of the beech and larch; they have not yet, however, been examined microscopically, hence these statements require confirmation. The climate of the Taimyr country appeared to be less cold than might have been expected: from the 6th of June to the 8th of August there was no frost there; constant fogs and storms (especially in summer, so that in May, June, and half of July, the altitude of the sun could only be taken three times,) indicated great irregularities in the distribution of heat in the atmosphere. The high surface of the country, which rises to an elevation of 1000′, was perfectly free from snow in the summer; even in the winter, storms sweep the snow into the lowest parts, frequently leaving the heights bare. In the middle of July, Middendorf saw at Taimyr 1500 square miles (Eng.) free from snow, in a few narrow valleys only was any still remaining. The lakes only freeze to a depth of eight feet; the layer of snow then protects them from any deeper penetration of the frost. As regards the botanical results, we must wait for further reports, on account of the want of accurate determinations of the plants.

The thermometric observations made by Stchoukine, from 1830-1844 at Irkutsk (1330 English feet above the level of the sea), give (the months being reckoned as lunar) the following average of temperature:

January . .	— 19°·9 c.	July . .	18°·5 c.
February . .	— 13°·6 c.	August . .	+ 13°·75 c.
March . .	— 3°·25 c.	September .	+ 6°·75 c.
April . .	+ 5°·75 c.	October . .	— 3°·75 c.
May . .	+ 12°·25 c.	November. .	— 14°·25 c.
June . .	+ 17°·6 c.	December. .	— 19°·9 c.

Mean temp. = + 0°·01 c.
Maximum = + 35° (once in 1843, 39°·5 c.)
Minimum = — 35°

Turczaninow's "Flora of the Baikal Regions" (see the Annual Report for 1842) has been continued, and has now reached the end of the Umbelliferæ (Bulletin de la Soc. de Moscou, 1843-44). The following families have thus far been treated of: 3 Rhamneæ, 94 Leguminosæ, 69 Rosaceæ, 5 Onagrariæ, 6 Halorageæ, 1 of the Ceratophylleæ, 1 of the Lythrariæ, 2 Tamariscineæ, 1 of the Portulaceæ, 8 Crassulaceæ, 1 *Nitraria*, 9 Grossularieæ, 19 Saxifrageæ, 48 Umbelliferæ, with the recently separated genera *Physolophium* (*Angelica saxatilis* Turcz.) and *Czernævia* (*Conioselinum Czernævia* F. M.) Altogether 542 Polypetalous plants have now been fully treated of.

Kittlitz's work contains some very interesting illustrations of the characters of the vegetation of Kamtschatka; his botanical sketches of the countries, which were made during the well-known voyage of the younger Mertens round the world, and described in the text with a perfect comprehension of the physiognomical characteristics, form one of the most valuable contributions to botanical geography made during the past year (Vierundzwanzig Vegetations-Ansichten von Küstenländern und Inseln des stillen Oceans, aufgenommen in den Jahren 1827-9 durch F. H. v. Kittlitz. Siegen und Wiesbaden, 1844-5, 4to). As we cannot omit making a full report upon this work,

we shall preserve as far as possible the excellent language of the text which accompanies the copper-plates; they afford a sample of the author's power of observation.

The physiognomy of Central and Northern Europe agrees with that of Kamtschatka much more completely than we should anticipate, considering the great difference between their longitudes: the number of European plants is very considerable (p. 53). The peninsula is divided into an eastern and western half by its mountain-chain. In the former, rise the conical volcanic mountains, of which the Kliutschewsk, according to Erman, is 14,800′ in height, or as Kittlitz expresses himself, they rival the Peak of Teneriffe in height, and excel all other volcanoes in the perfection of their conical form. They alternate with long mountain-chains whose rugged tops are covered with snow, whilst the remainder of the district is adorned with the growth of noble forests and pasture. On the west side, however, the coast is low and marshy, passing towards the interior into a broad plain of fertile land, the soil of which is watered by numerous streams, and is covered partly with woods, partly with luxuriant grassy plains in their original and natural state. For the purpose of carrying out this sketch completely in detail, the author has given five tables, which indicate the botanical character of the forests and grassy plains in the summer months (July to September).

Grass Plain at Awatscha, therefore in the neighbourhood of Peter-Paul's harbour (plate XVII). This picture represents a luxuriant woody prairie, abounding in plants, and containing scattered groups of shrubs, and the open surface of which is inclosed by a wood of birch (*Betula Ermani*). This birch is the principal forest tree of the country; it somewhat resembles the oak in the knotty and flexuous growth of its stem, and differs moreover from *Betula alba* in its bark, which is gray and much torn, whilst the leaves agree with those of the common birch. A thicket of alders and willows denotes the vicinity of the stream; some of these are shrubby, others

tall in growth, resembling that of the poplar, and with these woody plants the gregarious *Spiræa Kamtschatika* (Schalameynik), a plant which throughout the summer characterises Kamtschatka above all other countries, and here repeats the Panax-form of the north-west of America in a physiognomical point of view: "A plant of wonderfully rapid growth, which in a few weeks acquires a height of more than 10 feet, whilst in the autumn it disappears still more quickly, without leaving a trace, for a single frosty night is sufficient to cut it off to the ground." Above the large, crenate leaves, the stems display in July their white bunches of flowers, which subsequently acquire a gray tint. Single plants of a very tall *Heracleum* (*H. Panaces?*) grow among the Spiræas, from the juice of which the natives prepare sugar. The grass covering these prairies attains an astonishing height; at first, indeed, it is overshadowed by shrubs of *Cratægus* and *Salix*, with thick stems, which project here and there, but these at a later period scarcely extend above the rapidly developed culms of the grass. The same applies to the herbaceous perennials, which are mixed in large numbers with the Grasses, and of which the following are mentioned: 2 *Sanguisorbæ*, *Angelica*, *Epilobium angustifolium*, *Senecio cannabifolius*, *Cacalia hastata*, 2 lilies with large orange flowers (one with stems of the height of a man, probably *L. Kamtschatkense* Lour.), and *Fritillaria Kamtschatkensis*, the latter under the name of Sarannah. Of these, *Senecio* and *Epilobium* are the principal ones which contribute to the physiognomy of the land. The former, although as high as a man, is laden with flowers, and frequently colours the surface of the meadows of a pure yellow colour, whilst the latter produces a splendid red. The Sarannah, which is everywhere met with in short grass, yields in its tubers an excellent article of food, which, although difficult to dig up, often supplies the place of bread.

Plate XVIII leads us to the *Forest on the Upper Kamtschatka river*, which, lying in a valley running lon-

gitudinally towards the east, traverses plains that are extensive towards the north, and almost everywhere wooded. Here, but here only, a different kind of birch constitutes the predominant forest tree, which the author regards as one of the European species, and denominates *Betula alba* (*B. pubescens* of Erman). It is so distinctly separated geographically in the neighbourhood of the river from *B. Ermani*, that on the road from Ganal to Puschtschina, whilst from the coast to this place the latter only is met with, the white birch suddenly begins to form the forests as soon as the upper course of the Kamtschatka river is reached. Together with the birch, we here find drawn a group of tall balsam poplars as straight as a line; this tree by itself forms large woods in the middle of Kamtschatka. The underwood and shrubs consist principally of *Spirææ*, next of *Lonicera*, *Cratægus*, *Prunus*, and *Salix*. In the glades, in the midst of scanty grass, a dark blue *Iris* grows; it is everywhere common, forming an incomparable ornament to the country, and is succeeded at a later period by several Synantheraceous perennials with beautiful flowers, as *Aster*, *Achillea*, and *Sonchus Sibiricus*.

Forests of Central Kamtschatka (pl. XIX, XX). A strip of land extends across the middle of the peninsula, from the west towards Cape Kronotzkoi; it is wooded with Coniferæ, no trace of which exists in the other districts. The forests consist of two kinds of fir-trees, the larger of which resembles the Canadian larch, the other has the growth of our red pine, with which it is probably identical: here also the birch and the aspen are associated with them. As the pine-forests of Kamtschatka differ from those of the north-west of America in their dryness, so also the underwood merely consists of a thicket, 3 feet high, composed of Roses and *Loniceræ*, and beneath them again a large number of bacciferous plants are concealed, *Vaccinia*, *Rubi*, and *Empetrum*, exactly as occurs under similar conditions in Scandinavia, so much so, that even the species mentioned of these genera are identical with

them. Among the edible fruits, *Rubus arcticus* has the most agreeable taste; the elongated dark blue berries of a *Lonicera* come next, their taste is not inferior to that of the finest cherries, and they are prepared with milk or Sarannah to form a favorite article of food with the natives. The Kamtschatka river is constantly changing the course of its valley, and hence, like the rivers of Russia, its banks are steep (Jar) on the side excavated by the current, whilst sandbanks (Pessok) are deposited by the water on the opposite side. On the former, the old pine-forest extends down to the river, and by the falling in of the banks is carried away as floating timber; on the latter, different woody plants have settled, the period of formation of which is later than that of the former: first, thickets of willows, then larger deciduous trees, willows, alders, and poplars appear to follow. The difference in the foliage commonly expresses a difference not of the age of the trees, but of the period at which the district became wooded.

Mountain-Forests of the Eastern Coast (pl. XXI), extending over its steep declivities. These forests, which are also composed of *Betula Ermani*, and sometimes contain tall trees of *Salix*, appear far lighter than those in the fluviatile valleys; but the thickets of underwood and shrubs extending between the trees are proportionately thicker, and contain a larger number of plants. This character is evident, even at a level of 500′, and extends high up the mountain. But at a greater elevation, the birch trees gradually diminish in number, preserving the same state of growth, until at last they disappear, and give place entirely to the shrubs, just as the latter are displaced by the alpine flora, according to the same law. These thickets of shrubs are in general impenetrable to man, and represent the pine-region in Kamtschatka. They consist of *Pyrus sambucifolia* Cham., *Alnus incana*, and a pine which is probably a variety of Pinus Cembra, and is called Kedrownik. The former of these shrubs predominates in the lower regions, and disappears at an elevation of 1000′. The Kedrownik grows even in the

vicinity of the coast, but appears to be most widely diffused between 1000′ and 2000′. Its nuts are nutritious, and are eaten, as is also the fruit of *Pyrus sambucifolia.* The most extensive thickets consist of the northern alder, which also grows in the lower regions, in common with two others, but between 2000′ and 3000′ exists alone, limited by the alpine flora, bare stones, and eternal snow. On all the high mountains of Kamtschatka there exists a region in which it exclusively covers the soil. Its upper limit had been previously determined correctly by Erman to be 2890′, i. e. more than 2000′ beneath the snow-line (5000′); but *Salix arctica* (4974′), *Parrya Ermani,* and *Saxifragi Merkii* ascend as high as the latter.

Grass Plain in the West of Kamtschatka, on the Bolschaja-Reka (pl. XXII). The south-western slope of the peninsula is comparatively poor in pictorial beauty and botanical variety; the forest-growth is less than in the east, the morasses are more extensive, and bushes of willow predominate almost everywhere with the peat-moors. The landscape, which was taken in September, is remarkable from the astonishing height of two withering Umbelliferous plants, which give a most peculiar character to the grass plains of the west. They probably belong to the genera *Angelica* and *Heracleum;* their strong stems appear more than fifteen feet high; thus, growing in numbers, they project far beyond the Grasses and other herbaceous plants. We next have a tall gregarious *Urtica,* 10′ high, and from which the natives prepare a valuable yarn. The remaining plants agree generally with those of the grass plains in the east.

The Algæ of Kamtschatka are described and figured in the splendid illustrated work of Postels and Ruprecht; they were also collected in the expedition of the younger Mertens (Illustrationes algarum in itinere nauarchi Lütke collectarum. Petropoli, 1840, fol.)

Zuccarini has published a very valuable sketch of the Flora of Japan (Notizen über die Flora von Japan und die bisher hierüber vorliegenden wissenschaftlichen Lei-

stungen: in the Münchener gelehrte Anzeigen für 1841 and 1844, id. pp. 430 et seq.)

It must first be remarked, in regard to the notice given in the Annual Report for 1843, of the progress of the author's Flora Japonica, that this work has indeed experienced an interruption, but that by the completion of the part which treats of the *Coniferæ*, the number of this order found in Japan has been increased, far beyond that previously given, i. e. to 30, which are distributed through 14 genera. Zuccarini's present work contains a catalogue of all the genera as yet known in Japan, with the number of species in each family. The latter amount in all to about 1650 species; but as Zuccarini estimates the number of the Japanese plants contained in the herbaria of the Netherlands at 2400 species, the statistics must ultimately be altered in proportion as the still remaining families in V. Siebold's work are worked out. With the proportional numbers of the genera and families this will not be so much the case; hence Zuccarini's sketch acquires a permanent value. He enumerates the following as the most remarkable general results of his investigation: 1. The large number of families of plants represented in Japan, of which, according to Endlicher's system, there are 172. 2. The large number of genera in proportion to the species, for 621 are already mentioned in the catalogue, and probably 700 are contained in the herbaria (it must, however, be remarked, that Zuccarini has included the Chinese genera found in Beechey's voyage, as also those from the Bonin Islands). 3. The limitation of endemic genera to a single species, corresponding to the monotypes of the Canary Isles; a condition which applies to the greater part of the new genera from Japan, whilst the remainder contain at present only two, or, at the most, four or five species, and some monotypes also of North America and India, and the European Humulus, possess in Japan a second, but only a second species. 4. The very large number of woody plants in so high a latitude, both from woody families belonging

to the temperate as well as the tropic zone, from the latter of which representatives of the Palms, Pandaneæ, Lauraceæ, Ternstrœmiaceæ, &c., together with numerous bamboos, are here in part diffused further towards the north than in other meridians of the northern hemisphere. 5. The endemic character of the flora of Japan, which is not connected, like Siberia, with that of Europe, having but very few species in common with Europe. We have not space, unfortunately, to enter more minutely upon the consideration of the components of the catalogue of the genera; we shall, therefore, merely confine ourselves to the mention of those families which are remarkable from the number of species they contain, and to the enumeration of some of the characteristic botanical forms of Japan. The predominating families are: Synantheraceæ (124), Graminaceæ (90), Rosaceæ (90), Leguminosæ (72), Liliaceæ, in the extended sense (60, of these 25 are Smilaceæ), Cyperaceæ (48), Labiatæ (47), Ranunculaceæ (42), Umbelliferæ (40), Amentaceæ (38), Orchidaceæ (35, principally of North American and European genera), Ericaceæ (36, of North American genera), Coniferæ (30), Urticaceæ in the extended sense (about 30), Cruciferæ (30). Characteristic forms (excluding several tropical representatives): Melastomas (4), Zanthoxyleæ (6), Aurantiaceæ (10), Ternstrœmiaceæ (19), an *Opuntia*, the source of which is, however, doubtful, Magnoliaceæ (10), one of the Proteaceæ (*Helicia* Z.), Lauraceæ (18,) Palmeæ (4), Musaceæ (4 *Musæ*), Scitamineæ (7), the Hæmadorous *Aletris*, Dioscoreæ (5), 1 *Philhydrum*, Commelyneæ (5), *Eriocaulon* (4), and *Cycas* (1).

Zuccarini and v. Siebold have described some new genera of Japanese plants in the memoirs of the Academy of Bavaria (Plantarum quas in Japonia collegit de Siebold genera nova. Fasc. 1, l. c. iii, pp. 719-49). List of these genera: *Pityrosperma* (a Ranunculaceous plant with 3 species, one of which is *Actæa Japonica* Thunb.); *Pteridophyllum* (connecting link between *Hypecoum* and *Fumaria*); *Eucapnos* (*Diclytra spectabilis* D. C.); *Trochostigma*, with 5 sp. (probably the type of a new family

allied to the Ternstrœmiaceæ); *Corchoropsis* (one of the Tiliaceæ); *Tripetaleia* (doubtfully placed among the Oleaceæ); *Stephanandra* (affinity also doubtful, probably belonging to the Rosaceæ); *Ceraseidos* (one of the apetalous Amygdalaceæ plants); *Platycaria* (one of the Juglandeæ); *Schizocodon* (Polemoniaceæ); *Conandron* (allied to *Ramondia*); *Phyllostachys* (Bambuseæ). According to the author, the bamboo-stems of commerce, as also the pepper-canes as they are called, are obtained from the Bambuseæ, which are common in Japan, and of which there are 15; they seldom, however, flower, and therefore the species are but imperfectly known.

Royle has drawn up some remarks upon the vegetation of Afghanistan, Cashmere, and Thibet, from the truly very inconsiderable collections of Vigne (Travels in Cashmere, Ladak, Iskardo, &c., by G. T. Vigne, 2d edit. London, 1844, 8vo, Appendix). However, these fragmentary reports are of interest, on account of Royle's intimate acquaintance with the botanical character of the Himalayan mountains, the use he has made of other sources, and the general plan of his investigation. Thus he starts with the question of what constitutes the northern and western boundaries of the indigenous plants of the Indian plains. He considers it as an established fact, that the western boundary of the Indian flora along the Indus is formed by the Soliman mountains, and, in fact, the influence of the monsoon and summer-rains, upon which the vegetation of the tropical plains is dependent, disappears entirely in the district of this meridional chain, on the line from Kelat to Peshawar. Royle is especially indebted for the observations upon the western localities of Indian plants to the traveller Falconer, who is now his successor in the Botanic Garden at Saharunpore. The latter found *Butea frondosa* even on the Jhelum, the most westerly of the Punjab rivers; the Chenopodeæ of northern India accompanied it as far as Peshawar. Above Attock, on the Indus, the characteristic plants of the British Himalaya again recurred.

Even from Attock, according to Elphinstone (Cabul, p. 130), the tropical rains extend northwards as far as Hindu-Rusch, without the high flats of Afghanistan being moistened by them; for Surat would there form its western boundary, at which place, in summer, whilst e. g. rain still falls in Pukkely, the sky is overcast for a month only, and merely occasional showers fall. Thus the double harvests of the Indian year, which are occasioned by the rainy season, cannot be obtained west of Jellalabad (Irvine, Journal of As. Soc. of Bengal). Hence between Jellalabad and Gundamuc, on the road to Cabul, the periods of development of the vegetation are suddenly changed. "In Gundamuc," writes Burnes, "the willows flowered at the end of February. On the 11th of March the first spring flower appeared; it was a sweet-smelling Iris. The apricots began to unfold their buds on the 1st of April; the wheat here was three inches above the ground, whilst in Jellalabad it was already cut." But when we take into consideration the elevation of the soil above the Indus and its tributary streams, it appears clear that the tropical conditions of the vegetation only extend so far west in the valleys. In fact, Royle does not allude to the important question, to what elevation the mountain-slopes which limit these fluviatile valleys on every side are reached by tropical rains; but as regards Cashmere, a valley lying far to the east of Peshawar, we know that the atmospheric precipitations of the spring cease to occur at that period at which the rainy season commences in the Indian plains and the low valleys of the Himalaya. Thus it appears, from all the descriptions, that the more elevated regions in the neighbourhood of Attock and Peshawar are not subjected to the monsoon. This explains Elphinstone's statement, that a number of English plants thrive in the gardens at Cohaut, where plum and peach trees were in flower at the end of February, and where weeping willows, plane, and apple trees were thriving upon European meadow plains. From these reports, it is probable that the entire district west and north of the

Jhelum, or of the salt-chain, which is intersected by innumerable offsets of the Himalaya and Soliman mountains, with the exception of the lower fluviatile valleys, is free from all those Indian vegetable forms which, up to the foot of these mountains, are extended in an uninterrupted distribution over the Punjab.

But Royle's investigation passes over unnoticed a still more important aspect of the question regarding the boundaries of the Indian flora. Hitherto we have only treated of tropical forms of vegetation, to the growth of which the rainy season is unfavorable; but in addition to these, India possesses in the Himalaya and the monsoon region that mountain vegetation also, in which the European type is repeated. Here the question arises whether the areal limits of the latter are the same as those of the former, with which, in fact, they partly grow in common on the western chain of the British Himalaya, without, however, being favoured in the same degree, during their period of vegetation, by the tropical rain. The knowledge of this remarkable coexistence of the productions of two climates, for which we are also principally indebted to Royle's former investigations, has not induced him to devote his attention to the question of whether there are not forests of Himalayan trees in other regions which do not shade tropical plants in the rainy season. However, the simultaneous publication of Jacquemont's Journal at Cashmere has thrown some light upon this obscure point (Voyage dans l'Inde, vol. iii, p. 169). The traveller describes his journey from the Punjab to Cashmere over the Pirpanjol, the Himalayan Pass, which Royle, relying upon Bernier's descriptions, had formerly marked as a sharply-defined limit of the vegetation of the Indian flora, which assertion he now himself withdraws pretty openly. During the ascent, the pomegranate and olive trees disappeared at an elevation of 16—1700m., and soon after, *Pinus longifolia* also. A region of oaks, *Pinus attenuata*, and firs was next met with, which, on the northern slope of the chain, extended above the level of

the Pass (2681m.), whilst on this side it terminated below the alpine meadows. The alpine vegetation presented merely local differences from that of the British Himalaya; its spring-plants were in flower at the commencement of May. On the north side, therefore, Jacquemont first met with the same trees he had left on the southern slope, and further down, in the district of the valley of Cashmere, he arrived at forests of an *Æsculus* of the same species as that indigenous to the British Himalaya. The older opinions concerning the Pirpanjol, which Royle disseminated, are contradicted by these Reports. But as there is no tropical region in the valley of Cashmere, we have here also a proof that the diffusion of the Himalayan plants is not limited by the boundaries of the monsoon. The tropical forms of India may be wanting in Cashmere —and there is no evidence to show that they exist there —and yet the forest trees may appear the very same, and the character of the vegetation for the most part identical with that of the British Himalaya; in fact, the greater number of species may be common to both of them. The natives of the Pirpanjol say that it is always raining there (p. 225); hence this Pass may form one of the points of the boundary, as far as which tropical forms accompany the wooded slopes of the Himalaya. When thus considered, all the known facts are connected under a common point of view, but they are by no means sufficient for determining the absolute sphere of diffusion of all the Indian plants. Although Royle has rendered it probable that this area does not extend west of the monsoon-limit, yet the line at which the Himalayan plants cease, towards the north, is either totally unknown to us, as is the case beyond Cashmere, or merely indicated by uncertain evidence.

Royle's statements regarding the flora of the elevated plains of Afghanistan are very general; but where Griffith is his authority, the fragmentary notices derived from his letters are substantiated by the catalogue of a series of Afghanistan genera, the seeds of which were also transmitted by Griffith. They are nearly all European forms,

and principally the following: *Aconitum* and *Papaver;* 5 European Cruciferæ and *Tauscheria; Silene* and *Arenaria; Ruta* and *Peganum; Euphorbia* and *Phyllanthus;* several Astragalaceæ and *Caragana; Rosa* and *Cratægus; Epilobium; Prangos pabularia;* several *Carduaceæ* with *Centaurea* and *Cicorium; Campanula; Heliotropium* and *Onosma; Pedicularis, Linaria, Veronica,* and *Verbascum; Hyoscyamus, Samolus, Plantago, Hippophäe, Rumex,* and *Polygonum; Blitum; Iris* and *Tulipa.* Irwine treats fully of the cultivated plants of Cabul (loc. cit.) Wheat, barley, lentils, and peas are sown; they are protected during the winter by a layer of snow, and harvested in June. To the summer crops, which usually require irrigation, belong *Phaseolus radiatus, Cicer arietinum, Panicum miliaceum* and *Italicum,* maize, and rice; these are sown in May, and harvested in the months of August and September. Besides the European vegetables, *Solanum melongena* and several Cucurbitaceæ are cultivated, which require much manure and water. The meadows yield abundant crops of hay, and contain some excellent species of trefoil: one of these is denominated *Trifolium giganteum; Medicago sativa* is also widely diffused. The fruit trees of Cabul are celebrated: in addition to the fruits of central and eastern Europe, those of *Elæagnus* (Sinjet and Sinjilla) and *Edgeworthia buxifolia,* one of the Theophrasteæ, are mentioned.

Falconer discovered, in Cashmere, the plant yielding the Costus of the ancients, a substance which still forms an article of commerce in India, under the name of Koost or Koot. It is obtained from the aromatic root of a new alpine species of *Carlina* (*Aucklandia*), which Falconer has accurately described (Linnæan Trans., xix, p. 23). He has also proposed there (p. 101) the Asclepiadaceous genus *Campelepes,* from Peshawar. Falconer's so-called *Fothergilla,* which forms large bushes in Cashmere, and the wood of which, according to Vigne, is called Chob-i-pan, is a new type of the Persian *Parrotia* (*P. Jacquemontiana* Decs.)

From the elevated valley of Astore, between Cashmere and Thibet, Vigne brought the following plants: *Aconitum heterophyllum*, *Anemone discolor*, *Podophyllum*, *Dianthus*, *Geranium*, *Epilobium*, several Gentians, *Swertia* and *Ophelia Chirata*, *Polemonium cæruleum*, and *Dracocephalum Royleanum*. Here, far above the tree-limit, we find the elevated plain Deosuh, at an altitude of 13,000′, the soil of which is rendered verdant by dwarf-willows and alpine herbs, whilst the valley in which the Indus runs in Thibet is bare, a few plants occurring only at the snow-line. Falconer found here a new *Rheum* and two species of *Pyrola*, which, as Royle remarks, are the only Ericaceous plants in Thibet. Vigne's plants from Iskardo agree pretty accurately with the older collections from Kunawar: *Actæa*, some Cruciferæ, *Silene Moorcroftiana*, *Acer microphyllum*, *Myricaria*, *Biebersteinia odora*, *Astragalaceæ*, several *Potentillæ*, *Saxifraga stenophylla*, *Hippophäe* and *Salsola*.

Jacquemont's work on his travels, which has been mentioned above, is now complete, and affords extensive contributions to our knowledge of India in a botanico-geographical point of view, especially the flora of the British Himalayas and those of Thibet (Journal, vol. i-iii. Paris, 1841. Vol. v, Descriptions des Collections. Ib. 1844, 4to. 2 vols. plates). The admirably-kept journal of this traveller, which is printed unaltered, contains, of course in a fragmentary form only, the impressions produced by the character of the vegetation of the Himalayas, and separate regions of India; but in the last section of the work, the more rare and new plants of Jacquemont's herbarium are treated in systematic detail by Cambessèdes and Decaisne, and illustrated with 180 plates.

In Lesser Thibet, J. travelled on the road to Ladak, in the valley of Spiti, as far as Danker, where at an elevation of 17,000′, at the limit to vegetable life, he found the new Anthemideous genus *Allardia*, a *Nepeta*, and an *Urtica*. The villages in the valley of Spiti, according to Jacquemont, are situated on a higher level than that

formerly stated by Royle, e. g. Nako at 3658 m.; and the cultivation of the Cerealia, which is limited to *Hordeum hexastichon* and *cæleste*, and a *Panicum*, extends here to 3962 m., whilst in the southern Himalaya it only extends to 3048 m. Woody plants are not entirely absent from this elevated valley; even low trees, an indigenous *Juniperus*, and cultivated poplars and willows, are met with. The character of the vegetation, however, lies in the bushes, which was also noticed by Moorcroft These consist not only of thorny *Astragali*, but also of *Genista*, *Rosa*, *Ephedra*, and *Juniperus*. The absolute limit of elevation of the Phanerogamia west of Bekar was most accurately determined by Jacquemont. Here, in two passes leading from Thibet, Gantong (5486 m.) and Kimbrong (5581 m. according to Gerard's measurement), he left these plants below him. The leguminous shrubs of the valleys of Kunawar and Lesser Thibet were not found on the slopes of this pass, only a few alpine plants, the last of which was met with at Gantong, about 2—300 m. beneath the summit, hence at a level of 5200 m. Here he found two *Potentillæ*, *Corydalis physocarpa*, the new Caryophyllaceous plant *Periandra cæspitosa*, which resembles in appearance *Silene Acaulis*, with *Allardia* and *Eritrichium Jacquemontii* (Decs. ii, p. 309). Much lower down, the traveller met with a rose, forming the last shrub, and considerably lower still a *Juniperus*. At Kinbrong the vegetation also disappeared 300 m. below the pass, with a *Ranunculus*, *Corydalis*, and *Ligularia nana*; but at a level of 5400 m. Jacquemont saw an isolated green spot in the stony desert-waste. This was the highest evidence of vegetable life which he perceived (ii, p. 298). He estimated the snow-limit here at little less than 6000 m., so that between the last plants and perpetual snow there is an intermediate bare region extending through about 2000′.

As regards Kunawar, that remarkable transition-district between the British Himalaya and Thibet, on the central Sutlej, where the influence of the monsoon on

the seasons ceases, and the dryness of Thibet commences, Jacquemont's botanical observations agree with the more copious reports of Royle. The forests are very inconsiderable, the growth of grass poor, and kept down by Tragacanth-shrubs (*Astragali*), which are distributed as far as here; the alpine flora is also very scanty (ii, p. 269). Jacquemont devotes particular attention to the cultivation of the grape-vine, which is confined to this part of the Himalaya, not extending beyond the limits of the tropical rain (ii, pp. 416 et seq.) Although the grape-vine is cultivated at an elevation of 10,000′, this is only the case in the bottom of the valley, not on the mountain-slopes, for it only there receives the reflected rays of the sun, which are necessary to ripen the grapes, and there it is also protected from that radiation of heat which exerts too powerful an effect in cooling the earth on mountains. Moreover, even in the valley of the Sutlej, irrigation is indispensable to this branch of culture; but although the grapes under these circumstances mostly ripen well, they are usually dried in the sun, and used to make raisins, as the wine does not keep long, and even when new was found almost undrinkable by the Frenchman. We find the grape-vine as far upwards as Nako, in the valley of Spiti, and downwards as far as the mouth of the Buspa, where the climatic line above mentioned lies, and where the Sutlej intersects the high southern chains of the Himalayas.

The chains of the Southern Himalayas, which are situated immediately opposite to the plain of the north of India, do not possess any of that variation of soil, by means of which their vegetation might equal the flora of the Alps in variety, notwithstanding the mixture of forms of Tropical and European plants. Plane surfaces are scarcely anywhere found; and as we have already remarked, the broad valleys of Cashmere and Nepaul form exceptions to the mountain-character. Perpendicular precipices are also absent. We find everywhere vast inclined plains, and the mountain-stream usually entirely

fills up the bottom of the valley. Jacquemont says (ii, p. 130), "the vegetation which covers the inclined soil is as uniform as this conformation. Variety of localities causes a region to abound in plants, but here all the localities are alike." In the upper regions the forests are generally thin, and belong principally to the valleys. On viewing from a distance one of these immense declivities, on which there are scarcely any forests, we perceive lines of a darker green accompanying the few rivulets which water the mountain-slopes, at great distances apart. Between them the green is uniformly pale, for neither meadows nor mountain-pastures thrive there; but, with the exception of the summits of the rocks, an irregular and unfruitful growth of plants prevails among the blocks and the crumbled portions of rocks. High mountains occur, which, from the valleys to the crests, are covered with this mixture of rocks and plants only. More commonly a thin forest is distributed over a soil of this kind, between 6000′ and 7500′, consisting either of pine trees on the southern declivities, or the oak, with *Rhododendron arboreum*, on those which are colder. It is only at the foot of the mountains that dense forests, such as those on the Alps, flourish. The elevated forests of the Coniferous region of the Alps are not met with on the Himalayas.

At Massuri, Jacquemont measured the lower limit of the oak forest containing *Rhododendron arboreum*, and estimated it at 1768 m. (ii, p. 52). This measurement is tolerably near that given by Royle, who, in this district, determined the elevation of 5000′ to be the level at which the forms of the European forests appear in the place of tropical trees. In his ascent of the Kedarkanta, in the district of the source of the Jumna, Jacquemont also estimated the upper tree-limit at 3500 m. (ii, p. 127). The pine forests (species of *Abies*) terminated here, and were succeeded by a shrubby formation of *Rhododendron* (probably *Rh. lepidotum* Wall.); where this also disappears, the alpine soil is covered with turf, consisting of Grasses

and *Carex*, among which Ranunculaceæ most commonly spring up, with *Iris*, *Corydalis*, and *Phalangium*. The above measurement of the tree-limit appears to deserve the more confidence and to form an indication of climatic conditions, inasmuch as on the Kedarkanta the soil and inclination of the summit were favorable to forest growth.

Towards the end of his extended tours through the East Indian peninsula, Jacquemont's attention was drawn to an important peculiarity in the progress of the vegetation on the eastern coast of the district of the Ganges (iii, p. 550). In Bengal the soil remains green throughout the year, because the water flows off these plains so slowly, that it is retained deep in the soil during the dry season; also because in the winter dense fogs, and in the hot and dry months of spring, transient thunder-showers occur. Thus, when the traveller landed, on the 5th of May, at Calcutta (therefore on the coast), the turf was just as green as at the period of the heaviest precipitations in August. The treeless country of Puna, in the western Ghauts, however, in 1832 remained perfectly arid and parched, even in the latter third of June, just like the soil of the steppes; the surface of earth was without a trace of moisture, and, as it were, glowing in the sun's rays. Yet on the 1st of July the whole country was green, even the barest rocks had become covered with turf with wonderful rapidity. Hence the character of the monsoon flora is much more distinctly stamped here than at Calcutta: but the Bengal coast is anomalous in this respect. In the greater part of India, the vegetation of most of the plants is interrupted for a longer period by the dry season, than in Europe by the winter. The large shrubs, the sugar-cane plantations, and the turf of Paniceæ wither and dry up in November, and their vegetative life is not again aroused until June or July of the following year. At Puna the rainy season then lasted but little more than three months, and ceased at the beginning of November; but that year threatened to be unproductive, in consequence of too small an amount of rain having fallen.

In the descriptive part of Jacquemont's work, which, arranged in accordance with De Candolle's system, is worked out by Cambessèdes as far as the conclusion of the Rosaceæ, and the remainder by Decaisne, in addition to a large number of new species, the following genera, mostly from the Himalayas are proposed: *Christolea* and *Donepea* (Cruciferæ), *Oligomeris* (Resedaceæ), *Periandra* (vid. sup.), *Anquetilla* (Xanthoxylaceæ) *Leptopus* (near *Phyllanthus*), *Allardia* (v. s.), *Melanoseris* (Cichoraceæ), *Belenia* (Solaneæ), *Dargeria* (Scrophulariaceæ), *Lasiosiphon* (*Gnidiæ* sp. plures) *Girardinia* (*Urticæ* sp.), and *Diplosiphon* (a remarkable Epigynous and Monocotyledonous water-plant, the natural affinity of which is not determined).

The continuation of Bentham's work upon the Indian and African Leguminosæ, which was noticed in last year's Report, includes about a hundred Genistas, most of them from the Cape (London Journal of Bot. iii, p. 338-65).

The new parts of Korthal's Monographs on the Flora of the Indian Archipelago (Annual Report for 1841), contain the Melastomaceæ, Oaks, and the following genera: *Cratoxylon* and *Tridesmis*, *Hippocratea* and *Salacia*, and *Maranthes*; *Boschia*, nov. gen. (Sterculiaceæ), *Omphocarpus*, n. g. (near *Grewia*), *Paravinia*, n. g., and *Cleisocratera*, n. g. (Rubiaceæ). De Vriese has described a *Casuarina* (*C. Sumatrana* J.) found by Junghuhn in Sumatra in v. d. Hoeven's Tijdschrift (1844, p. 113), also some Javanese plants (id. p. 336-47); the only new plant is an *Æschynanthus*. New contributions by Hasskarl on various families of the Javanese flora are published partly in the same Journal (p. 49, iii; pp. 178-228), and partly in the Ratisbon Flora (1844, pp. 583 et seq.) Montagne has described some new Javanese Mosses (London Journal of Botany, 1844, pp. 632-4). Dozy and Molkenboer have commenced an illustrated work on the Mosses of the Indian Archipelago (Musci frondosi inediti Archipelagi Indici, Fasc. I. Lugdun. Batav. 1844). The preliminary diagnostic characters of about 75 new species have been published by

them in the 'Annales des Sciences Naturelles' (1844, ii, p. 297-316); among these are the new genera *Cryptocarpon*, *Endotrichon*, and *Symphysodon*.

An extremely important systematic and illustrated work, on the Flora of Java, which is now concluded, is that published by Bennett and R. Brown from Horsfield's herbarium (Plantæ Javanicæ rariores descriptæ inconibusque illustratæ. Descriptiones et characteres plurimarum elaboravit I. Bennett, observationes structuram, et affinitates præsertim respicientes passim adjicit, Rob. Brown, pt. i, Londini, 1838; pt. ii, 1840; pt. iii, 1844). This work contains 45 plates, and the following new genera: *Sclerachne* and *Polytoca* (Graminaceæ), *Hexameria* (Orchidaceæ), *Cyrtoceras* (Asclepiadaceæ), *Stylodiscus* (*Andrachne trifoliata* Roxb.), *Euchresta* (*Andira Horsfieldii* Lesch.), *Mecopus* and *Phylacium* (Leguminosæ), *Saccopetalum* (Anonaceæ), *Lasiolepis* (near *Harrisonia* Br.), *Pterocymbium* (Sterculiaceæ), and several types from other countries, which are elucidated in these copious disquisitions.

Junghuhn's diaries of his travels in Java, which have been already alluded to, were indeed first published, with additions, in 1845 (Topographische und naturwissenschaftliche Reisen durch Java, von F. Junghuhn, herausgegeben von Nees v. Essenbeck. Magdeburg, 8vo), but for the sake of connecting them with the preceding Annual Report, we think it better to report upon them now. In the western portion of the island, as at Gedé, the traveller found the mountain-ridges covered far and wide on both slopes with Rosamala-forests, i. e. with *Liquid-ambar Altingiana* Bl., the stems of which are recognised even at a distance by their tall straight growth and white colour, and which overshadow a thicket of Scitamineæ, *Melastomæ*, *Rubus*, and other shrubs (p. 165). A rich red soil here covers almost the whole of the trachyte of Gedé. According to several measurements, the region of the Rosamala-forests is situated at a level between 2000′ and 4000′ (p. 436): this tree, which is confined to the west of Java, occurs

singly as high as 4500′, and as low as 1500′. It is one of the most gigantic formations of the vegetable world, and attains on an average a height of 150′: the stems when cut down measure 15′ in circumference, 12′ above the root; their length below the point at which they branch amounts to 90′—100′, and the crowns extend to a height of from 50′ to 80′ beyond this. Cocoa palms would scarcely reach as high as these crowns. Above the Rosamala-forest on Pang-Gerango, came forests of Laurineæ, *Castaneæ*, Oaks, *Schima*, and *Fagræa*, which were far more abundantly filled with climbing plants (e.g. Freycinetias and *Calamus*) and parasites (Orchidaceæ and Ferns); and these again were succeeded by the Podocarpeæ. But even beyond the limits of *Podocarpus* the arboreal form is not wanting here, as is the case on other mountains. On the summit of Pang-Gerango itself, at a level of 9200′, *Thibaudia vulgaris* J. and an undetermined diœcious plant, 30 feet in height, with various other trees, form a wood abounding in Mosses, which, however, from its manner of growth, appears to belong to a vigorous growth of mountain pines (p. 452), although, even as far as this, a slender tree-fern, *Cyathæa oligocarpa*, from 15′ to 20′ high (extending from 5500′—9200′), is met with (see Annual Report for 1841, p. 449). "But," says Junghuhn, "we search in vain throughout the island for another example of such a wood on a mountain-top: all the mountains, far below this altitude, are either bare, being covered with lava and crumbled rocks, or overgrown with grass meadows of *Festuca nubigena* J. or with social Casuarinas." Junghuhn estimated the upper forest-limit on the Tjernai volcano (p. 235) at 7000′; it is formed by *Podocarpus imbricata* Bl., and is immediately succeeded by the subalpine shrubs (see preceding Ann. Report), and this appears to be the general manner in which the forests are distributed throughout the island. The true climatic arboreal limit of Java, which is only attained on the Pang-Gerango, and is here indicated by the mountain-pine formation of the wood on the mountain-top, is thus situated several thousands of feet higher than the apparent

one, which is merely produced by local conditions of soil, and thus Junghuhn, by his ascent of this mountain, has thrown some light upon an anomaly which has hitherto been almost inexplicable, viz. that the tree-limit in Java is so much lower than in the Himalaya, and that in general subalpine Ericaceous shrubs, with the northern alpine genera (e. g. *Ranunculus*, *Viola*, and *Gentiana*), descend there to an equally low level of 7—8000′. Yet the difficulty in explaining these deviations is not, in fact, completely removed by these observations, but merely confined within narrower limits; for although Pang-Gerango teaches us, that at 9200′ the most luxuriant woods still imitate the crooked stems of the mountain-pine, yet we find in India forests of tall fir trees at a level of more than 10,000′.

At the foot of the mud-volcano Galungung, Junghuhn describes the occurrence of almost impenetrable rush-formations, the marshy surface being thickly covered with *Saccharum Klaga*, 15′ in height, around which an *Equisetum* and *Epidendra* are coiled. Above these marshes, on the slope of the mountain, the forest of Urticeæ and Magnoliaceæ commences, including all those accessory components which render the attempt to describe tropical forests apparently impossible, even although we should not aspire to represent its copiousness by words and expressions, but merely to seize the distinctions in its mode of development and the conditions under which it occurs.

Just as the Rosamala-forests in the west of Java determine the physiognomy of the mountains, when covered by them, so in the eastern portion of the island do the forest-regions of *Casuarina equisetifolia*, which, however, are not met with below a level of 4000′; hence, although they ascend higher than other forms of trees, they are confined to the more limited space on individual elevated points. No trace of *Casuarinæ* is found west of Merapi, a mountain from which they are almost extirpated, whilst they do not appear to be absent from any of the mountain-tops which ascend on the east of it (p. 372).

Junghuhn gives the following statements regarding the altitudinal limits of some branches of cultivation in Java. Coffee might probably be cultivated as far as a level of 5000′, but at present the plantations do not usually extend beyond 3000′ or 4000′ (p. 234). *Artocarpus integrifolia* and *Arenga saccharifera*—3000′, *Duris zibethinus*—2000′ (p. 419).

Kittlitz gives two landscapes of districts in Manilla (Plates XXIII, XXIV), which, like all the others, are extremely characteristic, but deficient in sufficient botanical elucidation. Montagne has described the *Algæ* of the Philippine Islands from Cumming's collections (Lond. Journ. of Bot. 1844, pp. 658-62).

III.—AFRICA.

Of the botanical investigations of the French in Algeria but few notices have yet been published. Durieu met with extensive forests of cedar at Blidah, on the Lesser Atlas (Comptes rendus, vol. v, p. 18). As far as a level of from 7—800m. the mountain-slope was inhabited, and the soil cultivated; the oak then began to be intermixed with the fruit trees, and soon after single majestic cedars, 40 meters in height, were seen. But it was only on the southern declivity that the traveller met with connected forests of this tree, which are cut down annually by the inhabitants; they do not, however, appear to be destroyed as at Mount Lebanon, but are apparently readily reproduced. At Mascara, Durieu found *Callitris quadrivalvis* common, and increasing in frequency thence towards the south (Comptes rendus, vol. v, p. 19). Bory de St. Vincent has described some new species of *Isoëtes*, partly living upon a dry soil, from Algeria (l. c. vol. xviii).

We may now recur to Russeger's travels (Annual Report for 1842), since his work has proceeded to a considerable extent, and commenced the illustration of

the conditions of the climate and soil in a more tangible and definite style than was the case in the first volume, which treated of the East (Reisen in Europa, Asien, und Africa, Bd. 2. Stuttgard, 1843-45. In 1844, appeared the first part of this volume, including Egypt and Nubia, and the first number of the second part, containing Eastern Soudan). The climate of Lower Egypt, as far as Cairo, is that of the Mediterranean—a wet winter (ii, p. 263) and a serene summer. In Cairo we find the rainless zone of the north of Africa. At Cairo, according to the quinquennial average of Clot Bey, there are twelve rainy days in the year, with 0·034m. of rain. The absence of rain, both in Upper Egypt (Cairo to Nubia) and in the Sahara, depends upon constant north winds; hence Egypt is climatically a part of the Sahara.

The swollen state of the Nile, produced by the tropical rainy season, lasts from June to the end of September (i, p. 229). The months of October and November form the period at which the Cerealia are sown in those tracts of ground which are artificially flooded by canals; the harvests occur in February and March. Here, according to the kind of grain, a second crop may be sown in April, and reaped immediately before the irrigation. In other fields, the crop cannot be sown until December or January, and only once reaped, in May.

Sketch of the most important Branches of Cultivation, arranged according to the usual period at which the Crops are Sown and Reaped.

SOWN.	HARVEST.
January. Beans (Cerealia).	Sugar-cane.
February. Rice, maize.	Barley, melons.
March. Cotton.	Cerealia, maize.
April. (Cerealia.)	
May.	Figs, dates, grapes (Cerealia).
June.	Beans (Cerealia).
July.	Cotton.
September.	Oranges, olives, rice.
October. Cerealia.	Rice.
November. Cerealia.	Maize.
December. (Cerealia.)	

In the rainless zone of the north of Africa, in consequence of the duration of the polar currents, the great diurnal differences of temperature allow of the formation of dew to a slight extent; it occurs very copiously in the lower valley of the Nile, is formed in Upper Egypt, and appears also to fertilize the oases. Russeger, however, did not meet with any dew in the Desert of Nubia, but in that of Lybia it is common (ii, p. 253). The oases lying to the west of Egypt, according to Russeger, generally obtain their soil-water from the Nile, which flows laterally to them over beds of clay (p. 271). Thus they form a valley which is filled with springs, excavated below the level of the Nile, and parallel to this river. The other oases of the Sahara appear to be produced merely by the formation of dews. Borgu, Darfur, and Kordorfan, however, in this sense are not oases, but savannahs, situated within the rainy climate (p. 283).

The tropical rains extend in most years to, at the most, 18° N. lat. (i, p. 224), i. e. two degrees north of Chartum, the point at which the two arms of the Nile become confluent. The heavy rains fall there in the summer, and correspond to the south winds which blow at this time, and which prevail below 15° N. lat. from April to September, and alternate every six months with the north winds. The northern border of this monsoon-zone, which in the south of the Desert or Soudan produces savannahs, is not accurately determined. A short rainy season may occasionally occur beyond 18° N. lat., when the south winds blow as far as this part. However, the dry chamsin of the Desert, which blows from the same direction, and which Russeger regards as a local and electrical phenomenon, must not be confounded with these general south winds which bring rain. Even between 16° and 18° N. lat. the rainy period is irregular, and in many seasons abbreviated: at Chartum it lasts five months. Russeger assumes the following mean values as marking the north border of the tropical rainy zone throughout Africa:—21° N. lat. at the Red Sea,

18° at the Nile, 16° north of Tschad (according to Denham), and 20° in Senegambia (ii, p. 546). He forms a law on the great diurnal differences of temperature between the night and day, even within the rainy zone, which, if generally confirmed, would constitute a characteristic peculiarity of tropical Africa.

The whole of Nubia, as far south as 18° N. lat., except the valley of the Nile and the coast, consists, like Egypt, of rocky and sandy deserts. The heights here extend scarcely 1000′ above the plain, on the coast only ascending to 4000′, and in Dschebel Olba, according to Wellsted, to 8000′. The coast of the Red Sea is not free from rain; but on the Nubian side, the summer rains produced by the south-west monsoon extend almost as far as the latitude at which the tropical winter rains (as in Lower Egypt) commence. Suakim is situated on the northern border of the full rainy season (19° N. lat.); here, however, it occurs six weeks later (middle of July) than below 17°, and the summer rains are proportionately retarded and abbreviated as far as 21° N. lat., from which latitude northwards the winter rains commence. Although the upper portion of the sea north of Suakim is set in motion throughout the entire year by north winds, yet the African coast of the Arabian Sea is never free throughout the entire year from humid currents of air. This explains how it is that the entire coast line of Nubia is furnished with willows and other trees, whilst the inner country does not contain even oases. During the journey through the Desert, from Korosco to El Muchaireff, which occupied fifty hours, and is usually made to avoid the great bend of the Nile, Russeger only once met with brackish water, and that was in the middle of the journey.

The Nile leaves the zone of tropical rain at the influx of the Atbara, and again comes in contact with it by its bend at Dongola for a short distance. South of the mouth of the Atbara, savannahs begin to alternate with tropical forests, and this is the case throughout

the whole of Soudan: no more deserts are met with, except where the soil is rocky; they gradually pass into savannahs (ii, p. 525). The savannahs, during the rainy season, are overgrown with thick grass; in the other months they resemble a dry stubble-field. The forests consist of *Mimosæ*, and are crowded along the banks of the stream, as in Guiana. Near the rivers the rain district also extends further north; hence, at a considerable distance from them, even beyond the 18th degree, the creeks of the desert encroach upon the savannah.

Throughout the entire district of the Nile, at least as far as the 10th degree south, there are no terrace-like elevations of the soil west of Abyssinia, only immense plains. The terraces of Sennaar, Fazokl, &c., are geographical over-estimates (ii, p. 539). According to Russeger's barometrical measurements, the following places are situated at the annexed altitudes above the Mediterranean: Assuan (Syene), 342′, Par.; Korosko, 450′; Abuhammed, 963′; El Muchaireff, 1331′; Chartum, 1431′; Torra, on the White Nile, 1595; Eleis (13°), 1667′; and the capital of Kordofan, El Obeehd, 2018′. Russeger found the northern limit to the occurrence of *Adansonia*, in the savannahs of Kordofan, to exist below 14° N. lat.

On the coast of Adel, on the road from Tajura to the foot of the mountains of South Abyssinia, according to Harris's report of his travels (The Highlands of Ethiopia. London, 1844, vol. i, p. 412), the entire country was desert, and almost dried up in June, i. e. before the commencement of the rainy season, and the soil entirely uncultivated. When the heavy rains commenced it was stormy and unhealthy; one of the most uninhabitable parts of Africa. The flora was uncommonly poor; the woody plants consisted of shrubs of *Mimosæ* and *Cadaba Indica*, one of the Capparidaceæ; subsequently isolated Palms, *Cucifera Thebaica*, and below 11° N. lat. *Phœnix* were met with. The only other plants found at the end of the dry season were a few Capparidaceæ and Malvaceæ; and

of other botanical groups of the steppes, single forms only, as *Stapelia*, *Pergularia*, and some succulent Euphorbias; but at the river Hawasch the vegetation became social, by the formation of thickets of *Tamarix* or *Balsamodendron Myrrha*, with single Capparidaceous trees (i, p. 416). At the foot of the high mountains of Abyssinia, *Aloe Socotrina* was also met with, and soon after *Tamarix Indica*, with which the desert steppe was overgrown.

Harris read a paper on *Balsamodendron Myrrha* before the Linnæan Society (Ann. Nat. Hist. xiii, p. 220). This important shrub is called by the Danakil tribes, who inhabit the coast of Adel, Kurbeta. Myrrh (Hofali) is the milky juice which escapes from wounds made in it, dried in the air; it is usually collected in January, the period at which the buds unfold, and in March, when the seeds are ripe. *Balsamodendron Opobalsamum* grows on the opposite Arabian coast, at Cape Adem. The Frankincense trees of the mountains of Cape Guardafui, have not been botanically determined.

Harris's botanical reports upon Shoa are very unsatisfactory (The Highlands, &c. ii, pp. 395 et seq.) The pine of North Abyssinia is replaced in Shoa by the Det, a *Juniperus*, 160′ in height, with a stem from 4′ to 5′ in diameter, and with the growth of a cypress. Forest trees are also mentioned: *Taxus* (Sigba), *Ficus* (Schoala), and *F. Sycomorus* (Worka); moreover, Rüppel's Lobeliaceous tree, *Rhynchopetalum montanum* (Jibera), is common at Aukober, the stem of which is 15′ in height, and bears a crown of large leaves. Shrubs: an *Erica* (Asta) and *Polygonum frutescens* (Umboatoo) distributed generally. *Celastrus edulis* (Choat) is cultivated commonly, and resembles tea in its action and taste (ii, p. 423).

Harris's meteorological observations, which were made from August to December in 1841, and from January to July in 1842, in Aukober, the capital of Shoa, are of more importance. This place is situated below 9° 35′

N. lat., 8200′ above the level of the sea, and upon an open, cultivated flat. The climatic values are as follow:

	Mean Temperature.	Number of Rainy Days.	Quarter of the Wind.
January . .	11° 1 C.	—	East
February . .	12° 5 „	7	East and South
March . .	14° „	4	East
April . .	12° 9 „	14 (storms?)	East
May . . .	15° 4 „	4	East
June . . .	16° 7 „	8	East
July . . .	14° 5 „	28 } rainy season	Changeable
August . .	13° 2 „	26 } rainy season	Changeable
September .	13° „	13 } rainy season	North and East
October . .	11° 2 „	4	North and East
November .	11° „	4	North and East
December .	11° „	—	East

Mean temperature, 13° 1 C.; Maximum, 20° 6; Minimum, 5° C.

In Koolo (4° N. lat.), south of Enarea, on the confines of the pigmy Doco-negro tribes, according to the reports of the natives, the rainy season lasts from May to February with but slight intermission (iii, p. 64). To the north-west of this part, below the 5th degree of north latitude, the country of Susa is situated, high up on the prolongation of the Abyssinian mountains, and there, as at Shoa, the rainy season lasts only three months; but it must be colder there, for the mountains appeared to reach the sky, and were covered with perpetual snow. This is the district in which Bruce supposed the White Nile to arise.

Hochstetter has described some new Grasses found in Nubia and Abyssinia, from Kotschy and Schimper's herbarium, and after making some critical remarks upon the results obtained by Raffeneau, Endlicher, and himself in this branch of the Flora, proposes the following new African genera (Ratisbon flora, 1844): *Chasmanthera*, a Menispermaceous plant from Abyssinia; *Paulo-Wilhelmia* (Dombeyaceæ), from Nubia; also from Abyssinia, the Umbelliferæ, *Agrochoris*, *Haplosciadium*, and *Gymnosciadium*; *Discopodium* (Solanaceæ); *Hymenostigma*, and

Acidanthera (Iridaceæ); and *Clinostylis* (Liliaceæ). Fresenius has written notices of some Abyssinian plants (Bot. Zeitung, 1844, pp. 353-7). Fenzl has announced a work upon Kotschy's collections from Africa, and in it has enumerated a series of new forms, but without giving any descriptions (Ratisbon Flora, 1844, pp. 309-12).

A valuable notice of the plants collected by Krauss in the most southern regions of the Cape Colony, and in Natal, with a report on his travels, and a botanico-geographical introduction, has been published by the author (Ratisbon Flora, 1844, p. 46). He accurately describes the large elevated forests, which are limited to a small area, considering the extent of the whole colony, and extend along the south coast between Gauritz and the Kromme river and the foot of the Onteniqua mountains. According to his account, Drège's representation, contained in E. Meyer's work, of the generally poor character of the forests of the Cape, is not perfectly correct. At least in this district there exists a quantity of timber collected into woods, which Krauss characterises as impenetrable thickets. He mentions some gigantic stems of *Podocarpus*, which four men cannot span; moreover *Crocoxylon excelsum* (Safranhout), *Ocotea bullata* (Stinkhout), *Curtisea faginea* (Hassagaihout), and *Elædendron Capense*—trees, the large, densely leafy crowns of which are elevated far above the thicket beneath, and covered with numerous climbing plants. Underwood, e. g. *Burchellia*, *Gardenia*, *Canthium*, *Plectronia*, *Tecoma*, *Grewia*, *Sparmannia*, and *Rubus*. Lianes: *Cissus*, *Clematis*, *Cynoctonum*, and *Secamone;* Ferns in the deeply-shaded parts. After a tedious ascent, and laborious struggle through the chaos of bushes, is finally reached a thin wood, the trees become smaller and smaller, and their limit is soon attained. They are succeeded by shrubs of Synantheraceæ, Thymeleaceæ, Bruniaceæ, Proteaceæ, and Ericaceæ.

Krauss confirms the statement that the river Camtos constitutes a distinct limit of vegetation. This stream

might form the boundary between the flora of the Cape, and of the Caffre country; for here certain types of tropical Natal commence, whilst the Proteaceæ, Ericaceæ, Selagineæ, &c., diminish. The shrub-formations in Algoa Bay are taller and thicker than in the western districts; they serve as places of concealment for large Pachydermata. Characteristic forms of plants: Celastrineæ, *Euphorbia Canariensis*, *Strelitza*, *Zamia*, *Tamus*, *Pelargonium*, &c. This remarkable difference between the eastern and western provinces of the Cape Colony, which Bunbury also (London Journal of Botany, 1844, pp. 230-63) mentions and enlarges upon more in detail, is by no means to be so simply explained as the tropical peculiarities of the flora of Natal. At Graham's Town in Albany, Bunbury only found 13 plants in the extensive surrounding country, and these occur also at the Cape. Ericaceæ and Proteaceæ are rare, arborescent Euphorbias common, and the Restiaceæ replaced by Grasses. Extending along the Great Fish River, we find the wildest thickets of shrubs with arborescent Euphorbias, *Strelitzia*, and *Zamia horrida;* these are more impenetrable, and from the presence of spinous trees, more inaccessible than the natural Brazilian forests: they merely form the abode of large Pachydermata and border-robbers of the Caffre race. Tropical families of plants, single species of which only occur at the Cape, become numerous in Albany, especially Acanthaceæ, Apocyneæ, Bignoniaceæ, Rubiaceæ, and Capparidaceæ. These and other similar facts evidently indicate an approximation to the flora of Natal, although by no means to the extent these two authors suppose, viz. that the vegetation of Albany and Natal gradually run into each other. As long as the intermediate districts of the Caffre country are so little known, this must remain hypothetical, but is rendered extremely improbable by climatic laws. A resemblance of certain families and forms is by no means a resemblance of species and their combination into formations. But the increase of tropical forms in Albany is even considerably more mysterious than the

contrast between Albany and the west of the colony. In explaining the latter, we must bear in mind the narrow district throughout which the Cape plants are distributed, the tropical forms appear to indicate climatic influences which do not exist; for Albany is, if anything, unusually dry in comparison with the other regions of the colony, except the district of the Gareep. Rain, says Bunbury (p. 247), is rare and uncertain; when precipitations do occur, it is only the case during south or south-east sea winds. The climate is indeed considered very healthy, yet it is subjected to great and sudden changes of temperature, with stormy and dry winds from the west and north. Hence Albany does not exhibit any trace of that periodical rainy season, which at Port Natal, as the most southern point (30° S. lat.) of the regular tropical seasons, gives rise to the trade-wind character of the flora, and yet, in so dry a climate, the mode of formation of the plants is more similar to that of the trade-wind flora, than at the Cape, where in the winter regular precipitations occur almost as in the south of Europe. We must, therefore, in Albany, admit the occurrence of one of those botanico-geographical facts, where even a tropical constituent of the vegetation appears to be dependent not only upon climatic conditions, but historical or geological events.

According to Krauss, Natal is well watered by numerous rivers, which arise in the coast-chain Quathlamba; these mountains are nearly 10,000′ high, and run through the coast-country of the new colony in every direction. The vegetation springs up in September, and during the months of October, November, and December, corresponding with the atmospheric precipitations, attains the greatest splendour. During this moist season, the thermometer varies between 19° and 31° c. Vegetable life is suddenly arrested as early as January, the grass plains appearing dark yellow, and the forests flowerless and uniformly green. Rain seldom falls from January to March; the air during this period is hot and oppressive, and the temperature between 26° and 32° 5 c. The

same appears to be the case with the two following months, which Krauss did not spend in Natal; July and August are fine, the days hot (as high as 31°), but cool in the morning and evening; the thermometer, however, seldom falling so low as 15° c. A changeable, windy, and disagreeable period begins in September—the precursor of the rain. From these statements, the course of the seasons is the same as in the East Indies, except that the rainy season of three months occurs during the spring in the southern hemisphere, i. e. three months later than in the former.

Sketch of the predominating botanical formations:

1. Coast or forest region.

a. Forests of Rhizophoreæ in the mud between the ebb and flow of the tide (Mengerhout of the colonists). *Bruguiera Gymnorrhiza, Rhizophora mucronata, Avicennia tomentosa.*

b. Dense, tropical, mixed forests, which can only be traversed by the paths formed by the elephants and buffaloes. Among the trees several belong to the new genera published by Hochstetter, with *Ficus, Tabernæmontana, Zygia, Milletia, Phœnix reclinata*, &c. Underwood, Lianes, and the other components of tropical forests are copiously developed.

c. Grass plains with various shrubs.—*Musa.*

2. Hilly region, with beautiful pasture land, constituting the flower of the colony. The woods consist of Acacias. The Aloe and tall-stemmed Euphorbias resemble those in Karro. The highly nutritious grass, which consists principally of Andropogineæ, contains numerous shrubs, especially tropical forms of Leguminosæ, Scrophulariaceæ, Labiatæ, Acanthaceæ, and *Gnidia Kraussiana.*

3. Mountainous region. The above-mentioned extensive grass plains are succeeded upwards by a woody belt of *Podocarpus*, with numerous Ferns, and above this mountain-meadows of Cyperaceæ, with Orchidaceæ, *Ixia, Hypoxis,* and *Watsonia*, are distributed. The largest

number of the representatives of the botanical forms of the Cape occur in this region; but hitherto only two Proteaceæ, one *Aspalathus*, two Geraniaceæ, one *Muraltia*, one *Maternia*, and one *Barosma*, have been found in Natal, and not a single species of *Erica*, *Phylica*, *Selago*. *Oxalis*, Zygophylleæ, &c.

The summary of Krauss's Herbaria contains the diagnoses of several new species from Natal, and some from the Cape colony, published under the authority of those naturalists who have worked out the collections for the traveller. Among them the following new genera are proposed: By Bischoff, *Sphærothylax* (Podostomeæ); by Meissner, *Bunburya* (Rubiaceæ); by C. H. Schultz, *Monopappus* (Helichryseæ); and *Antrospermum* (Arctotideæ). Kunze has described some new Ferns from the Cape and Natal (Linnæa, 1844, pp. 113-24).

Bojer has continued his descriptions of new species of plants from the Mauritius and Madagascar (Troisième Rapport de la Soc. de St. Maurice); on this occasion they refer to the Anonaceæ, Menispermaceæ, Capparidaceæ, and Leguminosæ. Gardner has made a brief report upon some excursions in the Mauritius (London Journal of Bot., 1844, pp. 481-85).

IV.—ISLANDS OF THE ATLANTIC OCEAN.

Seubert has published a copious Flora of the Azores, in which his former memoir, which has been noticed in this work, is satisfactorily carried out, and brought to systematic perfection (Flora Azorica, Bonnæ, 1844, 4to). Of about 400 plants from the Azores, upon which his observations are made, fifty sp. are endemic, twenty-three sp. belong also to the Canarian Archipelago, five sp. to the continent of Africa, and six sp. to that of America; the remainder occur also in Europe. Of the endemic species, seven are Synantheraceæ, as many Cyperaceæ, and five Graminaceæ. Immediately after the

appearance of the Flora Azorica, Watson published a list of the plants which he collected in the Azores (Lond. Journ. of Botany, 1844, pp. 582-617); and thus increased the number of the Phanerogamia of these islands, which have as yet been made known, to about sixty species. As the plants belonging to the south of Europe found there are of less interest, we shall confine ourselves to his contributions to our knowledge of the endemic flora. He has admitted the following of Seubert's species into this category: *Plantago Azorica* Hochst. as a variety of *P. lanceolata*, and *Juncus lucidus* Hochst. as a synonyme of *J. tenuis* W.; also *Luzula purpureo-splendens* S., according to an older syn. *L. purpurea* Watson; and *Bellis Azorica* as a distinct genus, denominated *Seubertia*. Lastly, he has described five new endemic forms: *Hypericum decipiens* (*H. perforatum* S.?), *Petroselinum trifoliatum*, *Campanula Vidalii*, *Myosotis Azorica*, and *Euphrasia Azorica* (*E. grandiflora* Hochst.?) *Vaccinium cylindraceum* Sm. appears different to him from *V. Maderense* Lk.; but *Erica Azorica* Hochst. only a var. of *E. Scoparia*. The following may be mentioned as interesting discoveries of the plants of Madeira, and other adjacent floras in the Azores: *Melanoselinum decipiens* Hoffm., *Tolpis macrorrhiza* D. C., *Mirabilis divaricata* Lour., and *Persea Indica* Spr.

Seventy-five parts of the work of Webb and Berthollet on the Canary Islands are out. They carry the systematic part as far as the Synantheraceæ.

Reid has communicated some reports upon the cedar of the Bermuda Archipelago (Lond. Journ. of Bot., 1844, p. 266, and 1843, p. 1). The inhabitants erroneously consider this Coniferous plant (*Juniperus Bermudiana*) to be the same as the Virginian cedar (*Juniperus Virginiana*). Even the climate of these islands is very different from that of the opposite coasts of the American continent, as water never freezes in the Bermudas. The most magnificent oranges are produced there, being protected from the winds of the Atlantic by the large forests

of these cedars, which cover all the uncultivated regions. This tree is also called the pencil cedar, although the wood does not appear to be used at present in the manufacture of lead-pencils in England. It is much prized for ship-building. Reid thinks that the Bermuda cedar does not occur in the hot climate of the West Indies, but it is very common on the mountains of Jamaica.

V.—AMERICA.

The plants collected by Simpson and Dease, in their voyage of discovery on the arctic coast of America, have been named by Sir W. Hooker (Narrative of the Discoveries on the North Coast of America, by T. Simpson. London, 1843, 8vo, Appendix). These plants had, however, been previously found in Franklin's travels in the same region, and admitted into Hooker's Flora of British America, with the single exception of *Salix nivalis* Hooker, which was discovered by Drummond on the Rocky Mountains, and occurs also on the coast below 71° N. lat., west of Mackenzie.

A coast-landscape of Unalaschka, by Kittlitz (pl. IV), represents luxuriant meadows, in which various subalpine shrubs, forming most luxuriant thickets of plants, are intermixed with strong turf composed of Cyperaceæ: amongst the former are *Aconitum*, *Heracleum*, *Epilobium*, and especially *Lupinus*. The dwarf shrubs, also, of the alpine region, *Salices* and *Rhododendron Kamtschaticum*, extend on these islands, which are situated beyond the tree-limit, into the vicinity of the sea. Two views of the island of Sitcha, the forests of which they represent (pl. II and III), may serve as contrasts. They give a distinct representation of the mixed foliage of the Canadian larch (*Pinus Canadensis*) and a species of pine (*P. Mertensiana*), the growth of *Panax horridum*, the palmate auricled leaves of which are sometimes crowded together upon a turfy kind of brushwood, at others upon shrubby

stems, consisting of the *Vaccinia* and *Rubi*, forming the underwood, and other botanical forms, with which Bongard's sketch has made us acquainted.

After an interval of two years, the third part of the second volume of Torrey and Asa Gray's 'Flora of North America,' containing the completion of the Synantheraceæ, has appeared. A. Braun has described the *Equiseta* and *Charæ* of North America (Silliman's Journal of Science, vol. xlvi). Mac Nab read before the Edinburgh Botanical Society a botanical journal, which he had kept at Hudson (Ann. Nat. Hist., xiv, pp. 223-25).

Asa Gray has continued the report upon his botanical journey in the south of Alleghany (London Journ. of Bot. 1844, pp. 230-42). On the summit of the Roan, in Tennessee, the altitude of which is 6000′, *Rhododendron Catawbiense* forms a fertile subalpine shrubby formation, the turf of which consists of *Carex Pennsylvanica* and other species of this genus, with *Aira flexuosa* and *Juncus tenuis*. Beneath the shrubs, *Lilium*, *Veratrum*, *Potentilla*, *Geum*, some Ranunculaceæ, Umbelliferæ, Saxifrageæ, and *Solidago*, with *Rudbeckia*, *Liatris*, &c., are mentioned. The remaining woody plants, in addition to the Rhododoreæ and Rosaceæ, mentioned in the Annual Report for 1842, consisted of *Pyrus arbutifolia*, *Cratægus punctata*, *Ribes rotundifolium*, *Diervilla trifida*, *Vaccinium Constablæi* n. sp., and *Alnus crispa*. *Pinus Fraseri* is the tree which extends to the greatest altitude; it occurs near the summit in a dwarf and crooked form. At the end, A. Gray describes the new genus *Shortia* (*galacifolia*) from specimens in fruit in the herbarium of Michaux, who discovered it on the mountains of Carolina. It has not since been found, and its flowers are unknown. This remarkable plant unites the habit of *Pyrola uniflora* with the leaves of *Galax*. Nuttall described another genus (*Simmondia*) from S. Diego, in Upper California, as a new type of the Garryaceæ (l. c. p. 400, t. 16). The collections of Hinds (Ann. Rep. for 1842) have afforded the matter for an important systematic illustrated

work, which Bentham is working out, and the traveller elucidating by botanico-geographical remarks (The Botany of the Voyage of H.M.S. Sulphur. Edited and superintended by R. Brinsley Hinds. The botanical descriptions by G. Bentham. London, 1844, 4to). Five parts are now published. The representation of the character of the vegetation of California given in this work has a decided preference over the earlier ones, upon which we have previously reported. The flora of California resolves itself into two districts, a northern one, extending from the Columbia river to S. Diego (33° N. lat.), and a southern one, from here to the vicinity of the tropic, where the tropical forms of plants commence: the former corresponds to about the limits of Upper, and the latter to those of Lower California. South of Columbia (46°), where the forests of *Abies* terminate, the deciduous forests gradually continue to disappear: above S. Francisco (38°), there are no large forests, and altogether but few trees. In sailing, in Upper California, up the S. Francisco from the coast, a broad alluvial plain presents itself; it is open, and here and there sparingly wooded with oak trees like a natural park: the river flows through it, and floods it in the moist season. Bentham determined the trees to be, *Quercus agrifolia* and *Hindsii* and *Oreodaphne californica; Fraxinus latifolia* and *Æsculus californica* are also found there, and *Salices*, with *Platanus californica*, grow upon the banks of the river. At S. Pedro, the flora of Lower California prevails, and extends as far as the Magdalene Bay (24° 38′), where the most northern mangrove forests are found. Between these two points, the soil at different landing-places was either covered with low shrubs, which frequently fill the air with agreeable odours, or (in October and November) bare, like the steppes, and ornamented between the isolated portions of underwood with herbaceous plants with very beautiful flowers. Here the Synantheraceæ predominate, in the most varied forms and colours; in fact, they constitute more than the fourth part of Hinds's collection. Next to these,

the Euphorbiaceæ, Polygonaceæ, and Onagrariæ are more abundant than the remaining families: the entire Californian herbarium, however, only includes about 200 sp. The arid and frequently sandy soil is physiognomically characterised by different *Cacti*, 2 of which are distributed exactly as far as S. Pedro, and accurately define the extent of the flora. At Magdalene Bay, other tropical forms also begin to appear with the mangrove forests in considerable numbers, which are mixed in the text with the steppe-plants of Lower California, but which must of course be distinguished geographically from them. The Euphorbia-shrubs only are common to both the districts of the peninsula; nevertheless, the species which predominate within and without the tropic are different. Magdalene Bay appears to form a well-defined floral limit northwards. Together with Cape Lucas, it yielded one half of the plants contained in Hinds's Californian herbarium. But whether this tropical southern point of the peninsula forms a distinct and third botanical district, or should be considered as belonging to that of the western coast of Mexico, remains at present undecided, inasmuch as most of the plants collected here have not yet been described. The following are the families of the latter collection which contain the largest number of species: Synantheraceæ ($\frac{1}{5}$), Euphorbiaceæ ($\frac{1}{9}$), Leguminosæ ($\frac{1}{10}$), Graminaceæ, Solanaceæ, Malvaceæ, and Nyctagineæ. New genera from California, by Bentham: *Stegnosperma* (Phytolaccaceæ), *Serophytum* and *Eremocarpus* (Euphorbiaceæ), *Helogyne*, *Perityle*, *Coreocarpus*, *Acoma*, *Amauria* (*Synantheraceæ*), *Eriodictyum* (Hydroleaceæ). F. D. Bennett in a short time collected some 70 sp. on the tropical south point of California; they have not yet been made known (Narrative of a Whaling Voyage. London, 1840, vol. ii, p. 18). He saw there columnar *Cacti*, from 15′—20′ in height, and speaks of the luxuriance of the forests and of numerous succulent and bulbous plants.

Martens and Galeotti have continued their papers on

the flora of Mexico (Bullet. de l'Acad. de Bruxelles, 1844, vol. xi, part 2, pp. 61, 185, 319; 1845, vol. xii, p. 129): they contain 74 Labiatæ, with the new genus *Dekinia*, 39 Verbenaceæ, 9 Cordiaceæ, 30 Boraginaceæ, and 63 Solanaceæ. The Ferns (170 sp.) and Lycopodiaceæ (12 sp.) are treated of by them in detail (Mémoires de l'Acad. de Bruxelles, 1842), and are illustrated by copper-plates. Kunze has described the Ferns and the allied families collected by Leibold in Mexico (128 sp.) (Linnæa, 1844, pp. 308-52). V. Schlechtendal's continuation of his 'Contributions to the Flora of Mexico' contain the Sapindaceæ, a new Dioscoreaceous plant, and *Hydrotænia* (l. c. pp. 48, 112, 224). Bateman has published a splendid illustrated work on the Orchidaceæ of Guatemala and Mexico, with 40 plates (Orchidaceæ of Guatemala and Mexico. London, 1843, imp. fol.)

Galeotti, in his 'Memoir on the Mexican Ferns,' has also investigated their distribution in the regions which he has assumed, and commenced a similar work in connexion with Richard, in which the Orchidaceæ of Mexico, where, according to Richard's judgment, the forms of this family are more abundant than in any other country in the world, are treated monographically, from a collection of 500 species (i. e. ⅛ of all that are known), and the geographical distribution of which is given (Comptes rendus, vol. xviii, pp. 497-503) in a preliminary paper. The regions assumed by Galeotti in these two papers include the greater part of Mexico, without, however, as was the case with Liebmann's 'Characteristics of Oribaza,' their being supported by a sufficient number of special investigations. We cannot judge of the value of Galeotti's botanical division of the country until, as it is undoubtedly his intention to do, a special work is published on the botanico-geographical relations of all the Mexican families of plants. The altitudes given do not always agree with those of Liebmann, nay, in some cases, they do not agree with each other: how far this is due to inaccurate observation, and how far to local variation in

the limits of the plants, cannot be satisfactorily determined. In the following sketch of Galeotti's regions, the local displacements are added within brackets to the altitudes given.

1. Hot regions. 0′—3000′ (2500′). Vegetation from December to May (end of October to June) languid: most of the trees leafless.

a. Eastern coast with forests of Rhizophoras. Mean temperature = 95° c.

b. Moist mixed forests, not, however, containing many Ferns (R. chaude tempérée des ravins). Mean temperature, 25°—19° c.

c. Coast forest of the Pacific, 25°—19°.

2. Temperate regions.

a. Eastern slope. 3000′—6000′ (5500′, 7000′). This region differs from the coast in its great humidity and evergreen foliage. It contains tree-ferns, *Liquid-ambar*, evergreen oaks (à feuilles luisantes), and numerous Orchidaceæ. Mean temperature = 19° to 15°. In Oaxaca, this region is less distinctly separated from the others: the pine trees here descend as low as 3000′, whilst Myrtaceæ, *Melastomæ*, &c., are found even at an elevation of 7000′. The soil is calcareous, and Galeotti found there only 21 Ferns, whilst on the volcanic soil of Vera Cruz, he found 77 species at the same level.

b. Western slope. 3000′ (1000′) to 6500′. Mean temperature = 20° to 15°. To it a large part of Oaxaca, of Mechoracan, and Xalisco belong. Tree-ferns are not found there, and in fact few Ferns, but a large number of oaks, with numerous Orchidaceæ growing parasitically upon the bark, and some Palms.

c. Plateau, and the slopes adjacent to it, mean temperature = 20° to 15° (21° to 18°). The internal slopes of Mexico differ in every case, botanically speaking, from those situated externally, and inclined towards the two oceans. Their dry climate, for the most part, excludes the vegetation of Ferns and Orchidaceæ. These elevated surfaces are characterised by the large number of *Cacti*:

spiny *Mimosæ* and unparasitic Bromeliaceæ are common. The latter, with *Agave*, are frequently the only plants occurring on the calcareous soil; or on other kinds of mountains, the surface is extensively covered with *Prosopis dulcis* and *Mimosæ*. *Bronnia spinosa* is also characteristic.

3. Régions froides.

a. Eastern slope. The determinations of the altitudes of the upper stages of vegetation, e. g. at Oribaza, are in part inaccurate; thus, according to Liebmann's investigations, the statement that vegetation ceases at 12,500′ or 13,000′ is incorrect; this portion of the sketch is therefore passed over. This region has yielded 52 Ferns, most of which grow upon limestone, and also numerous Orchidaceæ (especially between 7500′ and 8000′).

b. Western slope and high mountains of the plateau. Botanical characteristics wanting. The upper limit to vegetation is situated, according to Galeotti, on Popocatapetl, at 11,500′, on the Pic of Toluca, at 13,000′.

c. Most elevated surfaces of the plateau. No botanical characteristics.

The second and larger section of Hinds's and Bentham's work (v. s.), which is, however, not yet perfectly completed, includes the west coast of America from S. Blas (21° 32′ N. lat.), to Guayaquil (2° 30′ S. lat.) On this long coast-line the flora is adapted to a moist tropical climate, and the shore covered with a dense forest; but the plants north and south of Panama are not the same. Nor are the seasons contemporaneous; the tropical rains commence at Guayaquil in the beginning of the year; towards the north, they gradually occur later, so that at S. Blas they commence at the end of June. They divide the year into two periods of vegetation; the Bay of Choco alone forms an exception, for there atmospheric precipitations last from ten to eleven months, producing a vegetation which is constantly green, and abounding in flowers. The forests of Guayaquil appear to be comparatively poor in forms, because the rainy season there, and with it the

luxuriant growth of the plants, in the vicinity of the Garua, only lasts for a short period. Of the characteristic tropical forms, some are absent, or rarely found; as Epiphytes, all the Monocotyledons, and the Ferns. North of Guayaquil the desert tracts again recur, in which the coast-stream at Salango (2° S. lat.) clothes a spot of land, like an island, with tropical trees; but as soon as the equator is passed northwards on this coast the vegetation acquires variety and strength. The Orchidaceæ and other Epiphytes then become more common; the number of forest forms rapidly increases in the same proportion as the duration of the rainy season augments, as far as the Bay of Choco (3°—7° N. lat.), where the vegetation of the western coast is most copiously developed; but the solstitial point is also reached at the same time. In this climate, the boundary of which is on this side of the equator, but which is still equatorial, the western coast contains its only Tree-ferns, and even here the *Cacti*, the characteristic plants of the trade-wind flora of America, are absent. At Panama (9° N. lat.) we again find a proportionate change of the two tropical seasons, hence no Tree-ferns nor Scitamineæ are met with there, but arborescent Cacti and other succulent plants. Most of the new species of the collection described by Bentham are from this south region of the western trade-wind coast (9°N. lat. to 3°S. lat.) North of Panama the influx of Mexican types is perceptible; Heliantheæ become numerous; the forests of mahogany at Realejo are also succeeded above by a region of *Pinus occidentalis*, and the oak is found even 1500′ above Acapulco. 654 species of the rich collection have already been described in the parts at present published, which extend from the Polypetalæ to the Scrophulariaceæ. Families containing most species: Capparidaceæ (10), Malvaceæ (31), Byttneriaceæ (11), Sapindaceæ (12), Leguminosæ (125), Melastomaceæ (23), Rubiaceæ (39), Synantheraceæ (95), Apocynaceæ (13), Bignoniaceæ (17), Convolvulaceæ (39), Boraginaceæ (23), Solaneæ (25), and Scrophulariaceæ (at present 17). Considering the

large number of new species, the number of undescribed genera is not great: *Triplandron* (Guttiferæ), *Pentagonia* (Rubiaceæ), *Oxypappus* (Synantheraceæ), *Stemmadenia*, 3 sp. (Apocynaceæ), *Diastema* (Gesneriaceæ), *Thinogetum* (Solaneæ), and *Leptoglossis* (Scrophulariaceæ).

Purdie, a collector for the Kew Gardens, has reported upon his travels in the West Indies (Lond. Journ. of Bot., 1844, pp. 501-33). Among others he ascended the peak of the Blue Mountains, in Jamaica, where the forests of the summit consist of *Podocarpus coriacea* (Yacca). In other respects these, as also Moritz's Botanical Letters from Cumana and Caracas (Bot. Zeit., 1844, pp. 173, 195, 431), merely give notices of the plants collected.

Miquel has continued his Contributions to the Flora of Guiana (Linnæa, 1844): some new Capparidaceæ, Sapindaceæ, Malpighiaceæ, Dilleniaceæ, Leguminosæ, Melastomaceæ (*Hartigia*, n. gen.), Memecyleæ, Passifloreæ, Onagrariæ, Cucurbitaceæ, Loranthaceæ, Rubiaceæ, Convolvulaceæ, Cuscutaceæ, Bignoniaceæ (*Callichlamys* = *Bign. latifolia* Rich.), *Avicenniæ*, Nyctaginaceæ, Polygonaceæ, Piperaceæ (*Nematanthera*, n. gen.), Bromeliaceæ, Musaceæ, Scitamineæ, Hydrocharidaceæ, Commelynaceæ, Xyrideæ, and Aroideæ. Steudel (Ratisbon Flora, 1844): on the Melastomaceæ from Surinam, and various plants in the collections of Hoffmann and Thappler, which are for sale. Robert Schomburgk (Lond. Journ. of Bot., 1844, pp. 621-31): a new Rubiaceous plant, and two Lauraceæ, from British Guiana. Berkeley on *Stereum hydrophorum* (Ann. Nat. Hist., xiv, p. 327).

Richard Schomburgk, who accompanied his brother during his last travels in British Guiana, has described in his letters the botanical characters of the explored regions (Bot. Zeit., 1844-5). We thus obtain an interesting supplement to the previous work of Robert Schomburgk on his travels, in which the botanical determination of the plants was omitted, and which, now that a great part

of the previous herbaria have been described, may be added to the descriptions of the country. The forest at Essequibo, from which *Mora excelsa* projects to an altitude of 160′, formed the first opportunity for the traveller to develope his descriptive talent. After having vividly delineated the crowded growth of the trees, the climbing plants and the creeping shrubs, which connect the stems in impenetrable meshes, and the parasites of the fallen trunks, he dwells upon a point with which we are less familiar—the *light of tropical forests*. On the ground the eye would miss the splendour of the flowers of other regions, and detect only Fungi, Ferns, and decaying vegetable structures; for even at noon a subdued light prevails in the forest, since scarcely anywhere is a portion of the sky visible through the closely-interlaced branches; but although the light is subdued beneath so dense a covering of foliage, there is more light than in dark pine forests. V. Kittlitz comes to the same conclusion as to the remarkable and as yet but little studied question, of how plants still thrive so well, and their green organs are able to respire, in shaded parts of the most dense vegetation which the crust of the earth anywhere produces (Vegetations-Ansichten, p. 6). "I was astonished," writes he, "to find so much light beneath the noblest trees, the widely-spread foliage of which scarcely anywhere allowed the sky to be seen. Remaining the same at the most varied times of the day, it could not be ascribed to the perpendicular light of noon, but only to those innumerable undulations of light which, falling from above through the crowded masses of leaves in every direction, being reflected from stem to stem and from branch to branch, finally reach the lower space in the thicket, and there produce a tone of dull lustre peculiar to tropical nature. In fact, what would become of that whole world of plants destined to live in this shade, if nature had not given the huge masses of foliage, which produce it, a *structure and distribution*, which permits it, although reflected a thousand times, still to reach in suf-

ficient power the plants living beneath." This problem may be expressed more definitely as follows. We have to explain why the shadow of obscure deciduous forests in the temperate zone are principally illuminated by transmitted, and in the tropics by reflected light, and why the Coniferous forests are poorer in these two luminous sources, and therefore so frequently deprived of plants growing in the shade. We first think of the *Mimosæ* and forms of Palms, of the compound, and therefore imperfectly shading forms of leaves, which thus contribute powerfully to the light tone of the tropical forests. But trees possessing this character form a part only, not the whole; for those forms with simple leaves, as the laurel- and Bombax-type, preponderate, in variety of form or size of the leaf. And even the form of the leaves of the Lauraceæ, which recurs in so many tropical families, is wanting in that transparent texture to which the light of the half-shaded parts of the northern deciduous forests is owing. But Kittlitz has pointed out another more universal character of the trees of tropical forests, in the arrangement of the leaves, which appears intended to complete the former. In climates where cold or aridity cause the winter-sleep of woody plants, they develope a very much larger number of small branches, which usually form a more connected, although on the whole poorer, stratum of leaves than in the tropics. This, therefore, throws a deeper shadow upon the ground, although it is more transparent; not so deep, however, as in the Coniferous forests, the crowded leaves of which are opaque. On the other hand, it is evident that the uninterrupted heat and moisture of the equatorial climate also ensure a longer duration of the first-formed branches, many of which, in the temperate zone, fall off or remain undeveloped, and must therefore produce fresh ramifications to allow of the necessary number of leaves being formed; these first branches attracting the currents of sap, continue to grow excentrically, and hence leave between their uppermost tufts of leaves, i. e.

the youngest and softest part, more or less broad intervals. Under this double condition of the formation and distribution of the foliage, we may perceive universally in the latter climate "a certain and wholly peculiar permeability"—seen only in its simplest and most developed state in the Palms—even in woody plants, which in other respects but little resemble the latter, and in which the more copious development of the ramifications of the stem produces this prevailing character, inasmuch as they imitate and replace the natural growth of the summit of Palms. "Large masses of very delicate foliage in this manner obtain so light an aspect, that they appear as it were to float in the air; but, even down to the smallest Fern upon the soil, everything exhibits a tendency to an excentric distribution, which does not permit the separate organs to press upon one another, but by the constant crossing of lines in every direction, produces spaces for the transmission of air and light." Here Nature addresses man like the noblest works of mediæval architecture, the pointed arches of which, of Arabian origin, have, it is supposed, borrowed that openness conjoined with gigantic masses and infinite variety of form, from two palm-stems with their penniform leaves in contact.

As the second principal formation of Guiana, R. Schomburgk describes the vegetation on the banks of the streams, at the border of the forest, as made generally known by V. Martius and Pöppig, from the north of Brazil. The underwood surpasses the retreating gigantic stems; a belt of Cecropias and bamboos forms the foreground; herbaceous lianes wind around the trees and bushes as in a most luxuriant hedge, on the borders of which beautiful flowering plants augment still more the most abundant variety.

From Essequibo the travellers went to the tributary stream, Rupununi, to arrive at the savannahs on the sea of Amuku, which in these regions cover the ridges of the land almost down to the water-line, and are only separated from the rivers by seams of woods from 100′

to 200′ in breadth. The main mass of the vegetation in the savannah consists of scabrous, straggling Graminaceæ and Cyperaceæ, from 3′ to 4′ in height, as *Pariana campestris, Chætospora capitata, Elionurus ciliaris, Sataria composita, Mariscus lævis,* intermixed with prickly or arborescent underwood of various kinds, as *Curatella Americana, Byrsonima, Plumieria,* Leguminosæ, Myrtaceæ, some Synantheraceæ, and Malvaceæ. The marshy places are denoted by *Mauritia flexuosa,* with Melastomas, Scitamineæ, Polygaleæ, and *Byttneria scabra;* the surface of the water itself, *Pontederia* and Nymphæaceæ.

Pöppig's illustrated work upon Tropical America is now completed by the 7—10 decades of the third volume (Lipsiæ, 1844, 4to). The 75th to 78th parts of Orbigny's Travels have appeared. Klotzsch has commenced the publication of 'Contributions to the Flora of Tropical America,' from the Museum of Berlin (Linnæa, 1844), comprising at present the vascular Cryptogamic plants and the Jungermanniæ, by C. Müller.

V. Tschudi's zoological work upon Peru contains, in the introduction, an interesting division of the Peruvian Andes, according to their climatal conditions and botanical characters (Untersuchungen über die Fauna Peruana, Lief i. St. Gallen, 1844, 4to). The climatal regions of Peru, the elevated surfaces and valleys of which are produced by the structure of the two Cordilleras, and are not dependent upon the polar altitude, are, according to Tschudi, as follows:

1. Western slope (contains no woods).

a. Coast region (0′—1500′). Mean temperature in the hot season = 27° c.; during the garua = 19°·75. A band of sand, 1620 miles in length, and from 18 to 60 miles in breadth, extending across the rivers, which intersect it many times, subdivides it into two principal formations; for the banks of the river form oases of cultivation in the Peruvian coast-steppe, the barren hilly surfaces of which are covered with fine quicksand, and are devoid of springs and, during the dry seasons, of vegetation. This

hot and dry season lasts from November until the end of April. The garua, a thin mist, which is thickest in August and September, reanimates the steppes from May to October. It only extends 1400′ high vertically in the atmosphere. As long as this prevails the steppe is verdant, and sends forth numerous Liliaceous forms into flower. The south winds generally last throughout the entire year; and V. Tschudi considers the formation of the garua as still unexplained. May they not arise, as winterly precipitations, from an admixture of the lower trade-wind with the east winds descending from the Andes, and which, during the summer, are not in a condition to separate the moisture from the coast trade-wind?

b. Internal coast-region (1500′—4000′). This comprises the fan-shaped expansion of the west valleys of the Cordilleras, which, at the time of the garua, is affected with a true rainy season. Mean temp. in the dry season, $=29°\cdot25$; in the rainy season $=22°\cdot75$. The vegetation is not very luxuriant, but the cultivated tracts are extraordinarily productive. The sugar-cane thrives well even at 3600′. Of fruits, *Anona tripetala* (Chirimoya) and *Passiflora quadrangularis* (Granadilla) are peculiar to this region.

c. Western Sierra (4000′—11,500′), or that slope of the Cordilleras which is gently inclined below, and steep above, with its narrow transverse valleys. The air is dry; the nights are very cold in summer; the prevailing wind is the east. In summer the mean temperature at noon is $=22°\cdot4$, at night $=10°$; in winter, the mean diurnal temperature is $=19°$. This is the region of the tropical Cerealia, and that in which the potato thrives readily and in profusion. *Oxalis tuberosa* (Oca) commences in it. The *Cacti* are among the characteristic plants of this slope, which contains but little wood.

d. Western Cordillera, comprises the west slope of the Andes above 11,000′, and the east declivity of this western crest as far downwards as 14,000′. It forms a wild mountainous tract, containing steep rocky declivities,

valleys expanded into small plains, and numerous alpine lakes, and is bounded by glaciers and perpetual snow. Cutting, ice-cold winds from the east and south-east prevail constantly. Mean temp. of the day in summer $= + 11^\circ\cdot25$, of the night $= - 7^\circ\cdot1$; in winter, i. e. during the rainy season, of the day $= + 7^\circ\cdot5$, of the night $= + 2^\circ\cdot6$. The vegetation extends to 15,500′, and consists of low *Cacti* and alpine plants.

2. Eastern declivity (two regions containing no forests, two wooded).

a. Puna region (11,000′—14,000′), or the large undulating plateau between the two Cordilleras, and which attains a mean altitude of 12,000′. Sparingly overgrown flats alternate with extensive marshes, lakes, and alpine rivulets. Cold west and south-west winds blow throughout the year, most violently from September to May, with fearful thunderstorms, which occur almost daily during these months. Thus the rainy season commences in the opposite half of the year to any one travelling from the coast to the interior. The sky is clear from May to September, and the nights very cold; the temperature is altogether very variable; it frequently varies within twenty-four hours 22 or 25 degrees; not unfrequently, on these cold heights, we suddenly encounter warm currents of air from the S.S.E., which at times are only from two to three paces in breadth, while in other cases as much as several hundred feet, and which rapidly recur (p. xxiv). Tschudi gives, as approximative mean values of the temperature: Summer (November to April, which period is there incorrectly called the winter), of the night $=+1^\circ\cdot5$, of noon $=8^\circ\cdot75$; winter (May to October, there incorrectly called summer), of the night $=-6^\circ\cdot25$, of noon $=12^\circ\cdot1$. The vegetation of Puna is poor; *Stipa Ichu* is abundant; Synantheraceæ, Malpighaceæ, Leguminosæ, Verbenaceæ, Scrophulariacæ, and Solaneæ are mentioned. Barley does not ripen at 13,050′.

b. Eastern Sierra (11,000′—8000′), consists of broad,

open, fluviatile valleys, the most thickly populated in Peru, and is separated from that of the Puna by rocky declivities; rainy season, with frequent hail, from October to February. During the winter months (also called summer in the text) dry east winds prevail; night frosts set in after the end of the rainy season, and the Cerealia are harvested. Mean temp. during the rainy season: of the night $= + 5°{\cdot}1$, of the day $= + 14°{\cdot}1$; during the winter (March to September), of the night $= - 4°{\cdot}25$, at noon $+ 17°{\cdot}1$. But great local differences occur in the hot bottoms of those valleys which are sheltered from the winds, where fruits of the south of Europe, as peach trees, thrive, sometimes even at an altitude of more than 10,000′; the principal cereal grain appears to be maize. The slope of this region, which, like the former, is destitute of woods, contains a profusion of *Cacti*, and on the banks of the streams only we find woods of *Salix Humboldtiana*, 20′ in height; even European fruit trees do not thrive when cultivated. In the valleys, however, this region extends directly into the forest region, from which it is also separated by a second Puna, i. e. by the crest of the central Cordillera.

c. Upper forest region or Ceja-region (from Ceja de la Montagne, i. e. the brow of the mountain) (8000′—5500′), comprises the eastern slope of the internal Cordillera, and its western slope in the north of Peru, with the longitudinal valley of Huallaga. It consists of steep rocks and narrow, wooded mountain-ridges. The climate is humid, cold, and rough, with prevailing south winds. Towards evening dense mists are formed, which during the night rest upon the forests, and which the wind carries away with it from the morning until the serene evening. These mists extend downwards as far as 6500′, and often resolve themselves into very heavy showers. The differences in the seasons are not mentioned; the observations upon the temperature are also incomplete. Low trees and shrubs covered with mosses commence even at 9500′, and increase in size and strength as we ascend. Cerealia

cannot be cultivated in this region, which is not exposed to the direct rays of the sun; potatoes grow abundantly.

d. Lower forest region (5500′—2000′), is composed of immense forests, savannahs, and marshes. Its humidity is great throughout the year; for even in the dry season (May to September) thunderstorms are common. The true rainy season begins in October, and lasts until March or April. Mean temp. = 30°; when the wind is in the east, the nocturnal temperature sinks to 18°·75. This region forms the commencement of the primæval forests of the Amazon.

Contributions to the Flora of Brazil: Moricand, Plantes nouvelles ou rares d'Amérique, livr. 8, Tab. 71-84 (Genève, 1844, 4to); Naudin, Description de Genres nouveaux de Mélastomacées (Ann. d. Sc. Nat., 1844, ii, pp. 140-56): *Tulasnea, Brachyandra, Eriocnema, Augustinea, Stenodon,* and *Miocarpus;* Fischer and C. A. Meyer, *Asterostigma,* n. g. Aroideæ (Bull. Pétersb. iii, p. 148). Miers, *Triuris* and *Peltophyllum,* forming the new family Triurideæ, allied to the Juncagineæ (Transact. Linn. Soc. xix, pp. 77, 155); Sir W. Hooker and Wilson, Enumeration of the Mosses and Hepaticæ collected in Brazil, by G. Gardner (Lond. Journ. of Bot., 1844, pp. 149-67). K. Müller, Enumeration of the Mosses collected by Gardner in Brazil (Bot. Zeit. 1844, p. 708), gives no description of the new species, so that the preceding publication, which is founded on more complete materials, acquires priority as regards the nomenclature.

Tenore has described a new *Aristolochia,* from Buenos Ayres, which he obtained from Bonpland's collection of seeds, and has taken this opportunity of republishing the diagnosis of some plants derived from the same source, and described in his catalogue of seeds (Rendiconto di Napoli, 1842, pp. 345-8).

Kittlitz's first plate represents the botanical character of the coast of Valparaiso. It gives a view of one of the steppes during the dry season, the bare soil of which appears only to produce *Cacti* and shrubs with stellate

prickles, but in which, during August and September, the most luxuriant grass plains, with their bulbous plants, are found. The following are some of the physiognomically important forms of plants represented in this drawing: the Caves (*Mimosa Cavenia*), the dwarf-pine-like Lithi (*Rhus caustica*), *Cereus Peruvianus*, *Puretia coarctata*, Synantheraceous shrubs, bamboos, &c.

Miers has proposed two genera of Iridaceæ from Chili —*Solenomelus* (*Cruckshankia* ej. ol.) and *Symphostemon* (*Sisyrinchium odoratissimum* Cav.) (Transact. Linn. Soc. xix, p. 95). Sir W. Hooker has determined the Alerse tree of the south of Chili, which is used as timber for building, to be *Thuja tetragona* (Lond. Journ. Bot., 1844, p. 144). Berkeley has described an edible Fungus from Terra del Fuego; *Cyttaria* n. gen., near *Bulgaria*, also containing a species from Chili (Transact. Linn. Soc., xix, p. 37).

VI.—AUSTRALIA AND SOUTH-SEA ISLANDS.

F. D. Bennett remarks that westerly winds, corresponding to the monsoon, not infrequently extend eastwards over the Pacific Ocean towards the Society Islands, and especially in February and March are not infrequently taken advantage of, for making voyages in a south-easterly direction; consequently in regions which, in other respects, are completely under the influence of the south-east trade-wind (Whaling Voyage, i, p. 159). The botanical communications, which form an appendix to the account of his voyage, and which treat especially of the cultivated plants of the South Sea Islands, contain, in addition to numerous well-known facts, many names of Polynesian plants.

The illustrations of the Caroline and Marian Islands, and the archipelago of Bonin, are among the most excellent and richest views in Kittlitz's work; but the

systematic determination of the plants figured is entirely wanting—a deficiency caused by the early death of Mertens. The vegetation of tropical forests has, in fact, never been more distinctly represented than in these landscapes, except by Rugendas. The characteristic types of the most important physiognomical forms of tropical foliage are principally found in the following plates: Bamboo form, indicated by *Artocarpus* (pl. X); Banana, form expressed by the *Rhizophoræ* of the mangrove forests (pl. V), and stems of *Ficus* supported by aerial roots (pl. VI); Cycadeæ (pl. XI), Palmeæ (pl. IX, XVI), Musaceæ (pl. VII), *Pandanus* (pl. X, XI, XII, XV), and that of the Tree-ferns (pl. XVI). Of other physiognomical forms, Lianes (pl. VIII, XV), *Freycinetiæ* (pl. VI), parasitical Ferns (pl. V, VI), Aroideæ (pl. VII), *Agave*, imitated by stemless species of *Pandanus* (pl. XI, XII), herbaceous Ferns (pl. VIII). Pl. XIII represents the savannahs on the Marian Islands; grass plains with *Casuarina*, *Cycas*, and *Pandanus*.

Suttor's paper, read before the Linnæan Society, upon the Forest Trees of New Holland contains, according to the extracts before us, only well-known facts (Ann. Nat. Hist., xiii, p. 217). Drummond's Letters from the Swan River have been continued (Lond. Bot. Journ., 1844, pp. 263, 300). They contain, for the most part, notices of individual plants which were transmitted to Hooker. The extensive herbaria brought by Preiss from the Swan River have been systematically described in detail in a separate work, edited by Lehmann, by a number of scientific men, mostly Germans (Plantæ Preissianæ sive enumeratio plantarum, quas in Australasia occidentali et meridionali—occidentali collegit L. Preiss. Ed. Chr. Lehmann. Vol. i. Hamburghi, 1844-1845, 8vo). The coadjutors were—Bartling, Bunge, Klotzsch, Lehmann, Meissner, Miquel, Nees v. Essenbeck, Putterlick, Schauer, Sonder, Steetz, Steudel, and De Vriese. Summary of the families treated of, with the enumeration of new genera, and those containing most species: 247 Legu-

minose (Meissn.); 63 *Acaciæ*, 10 *Chorozema*, 15 *Gompholobium*, 11 *Jacksonia*, 23 *Daviesia*, 15 *Gastrolobium*, 10 *Bossiæa*, Rosaceæ 1 (N.), Chrysobalaneæ 1 (N.); 161 Myrtaceæ (Sch.), 15 *Verticordia*, 14 *Calycothrix*, *Symphomyrtus* n. gen., 15 *Eucalyptus*, 33 *Melaleuca*, 10 *Beaufortia*, 15 *Calothamnus*; 3 Halorageæ (N.); Onagrariæ 1 (N.); 2 Oxalideæ (Steud.); Lineæ 1 (Bartl.); 6 Geraniaceæ (N.); 2 Zygophyllaceæ (Miq.); 25 Diosmeæ (Bartl.); *Boronia* 15; 12 Euphorbiaceæ (Kl.); *Trachycaryon* (*Croton* sp. Lab.); *Calyptrostigma* (*Croton* sp. Lab.); *Lopadocalyx* n. gen.; 3 Stackhousiaceæ (Bg.); 22 Rhamneæ (Steud.); *Pomaderris* 10; *Cryptandra* 10; 13 Pittosporaceæ (Putterl.); 17 Polygalaceæ; *Comesperma* (Steud.); 15 Tremandraceæ (Steetz); 11 *Tetratheca; Platytheca* n. gen.; 10 Sapindaceæ (Miq.); Olacineæ 1 (Miq.); Hypericineæ 1 (N.); 32 Byttneriaceæ (Steud.); *Thomasia* 19; *Fleischeria* n. gen.; 11 Malvaceæ (Miq.); Phytolaccaceæ 1 (Lehm.); 5 Caryophyllaceæ (Bartl.); 5 Portulaceæ (Miq.); *Tetragonella* n. gen.; 2 Mesembryanthemeæ (Lehm.); Frankeniaceæ 1 (N.); 20 Droseraceæ (Lehm.); *Drosera* 17; 8 Cruciferæ (Bg.); *Monoploca* (*Lepidii* sp. D. C.); 6 Ranunculaceæ (Steud.); 44 Dilleniaceæ (Steud.); *Hibbertia* 26; *Candollea* 11; 3 Crassulaceæ (N.); Cephaloteæ 1 (Lehm.); 8 Loranthaceæ (Miq.); 31 Umbelliferæ (Bg.); *Platysace* n. gen.; *Schœnolæna* n. gen.; 99 Epacridaceæ (Sond.); *Astroloma, Brachyloma* n. gen.; *Leucopogon* 47; *Andersonia*, 14; 3 Primulaceæ (N.); 8 Lentibulariæ (Lehm.); 6 Scrophulariaceæ (Bartl.); 5 Solanaceæ (N.); 5 Convolvulaceæ (De V.); 5 Boraginaceæ (Lehm.); 8 Myoporinaceæ (Bartl.); 2 Verbenaceæ (Bartl.); Avicennieæ 1 (Miq.); 25 Labiatæ (Bartl.); *Colobandra* 6, n. gen.; *Anisandra* n. gen.; 6 Gentianaceæ (N.); Apocynaceæ 1 (Lehm.); 5 Loganiaceæ (N.); 4 Rubiaceæ (Bartl.); 69 Stylidieæ (Sond.); *Stylidium* 64; *Coleostylis* (*Stylidii* sp. Benth.) *Forsteropsis* n. gen.; 18 Lobeliaceæ (De V.); *Lobelia* 17; *Vlamingia* n. gen.; 59 Goodenovieæ (De V.); *Dampiera* 15; *Scævola* 27; 101 Synantheraceæ (Steetz);

Eurybia 11; *Gymnogyne* n. gen.; *Silphiosperma* n. gen.; *Pogonolepis* n. gen.; *Pachysurus* n. gen.; *Chrysodiscus* n. gen.; *Chthonacephalus* n. gen.; *Anisolepis* n. gen.; *Pterochæta* n. gen.; *Siemssenia* n. gen.; *Hyalosperma* n. gen.; *Schœnia* (*Helichrysi* sp.); 2 Plantaginaceæ (N.); 208 Proteaceæ (Meissn.), *Petrophila* 21, *Isopogon* 15, *Adenanthos* 10, *Conospermum* 17, *Grevillea* 29, *Hakea* 46, *Banksia* 19, *Dryandra* 22; 16 Thymeleaceæ; *Pimelea* (Meissn.); 7 Laurinaceæ, *Cassyta* (N.); Nyctagineæ 1 (N.); 6 Polygonaceæ (Meissn.); 14 Amarantaceæ (N.); *Trichinium* 19; 14 Chenopodeaceæ (N.): Urticaceæ 1 (N.); 9 Casuarineæ (Miq.); 2 Coniferæ (Miq.); *Actinostrobus* n. gen.; Cycadaceæ 1; *Macrozamia* (Lehm.) Hence at present about 1450 Dicotyledons.

Gunn has addressed some botanical letters from Van Diemen's Land to the editor of the 'London Journal of Botany' (1844, pp. 485-96). He describes an excursion to the western highlands of the island, and gives statements of the localities of rare plants, with a more detailed report upon a new species of *Eucalyptus* (*E. Gunnii*) (Hooker, *fil.*), which in December and January contains a large quantity of a saccharine and fermentable juice, whence it is called by the colonists the cider-tree. As it forms extensive mountain-forests, it will probably hereafter become an important product of Tasmania. Harvey has described some new *Algæ* from Van Diemen's Land (id. pp. 407, 428); amongst them the Rhodomeleaceous plant, *Pollexfenia*, which is also indigenous to the Cape. Contributions to the Flora of New Zealand: Catalogue of a Collection of Plants from New Zealand, by Stephenson, determined by J. D. Hooker (Lond. Journ. Bot., 1844, pp. 411-18)—it contains but few new species; Hepaticæ Novæ Zeelandiæ et Tasmaniæ, by J. D. Hooker and Taylor (id. pp. 556-82); Diagnoses of New Zealand Plants, by Raoul, preliminary to his illustrated work, which was published in 1846 (Ann. Sc. Nat., 1844, ii, pp. 113-23), with the new genera: *Ileodictyon* (Fungi), *Pukateria* (Corneaceæ ?), and *Tetrapathea* (Passifloreæ).

Colenso's Botanical Diary of his travels during several months through the little known interior of the northern islands of New Zealand (Lond. Journ. Bot. 1844, pp. 4-62) contains numerous localities of, and reports upon, newly-discovered plants which have not yet been made public, but will be described in Dr. Hooker's illustrated work.

The first three parts of the latter work have appeared; they contain a general introduction upon the botanical characters of high latitudes of the southern hemisphere, and also the commencement of a flora of the Auckland Archipelago (The Botany of the Antarctic Voyage of H. M. Discovery Ships Erebus and Terror, under the command of Sir J. Ross; by Jos. Dalt. Hooker. Parts i-iii, London, 1844, 4to.) Being, during the summer, almost always either in high barren latitudes, or on the open sea, Hooker had but little opportunity of collecting other than such plants of the antarctic flora as flowered in the winter or spring. But he considers this defect, which concerns the copiousness of the materials which he collected, as of little consequence, as he was in the favorable position of being able to make use of the botanical results obtained in all the earlier British voyages to the South Pole, but of still less, in consequence of a climatal peculiarity which he developes in the introduction, and regards as the most characteristic feature of the antarctic vegetation. He was surprised on finding at Kerguelen's Land, the same plants in flower which Cook had met with at other seasons, and this result he subsequently found to occur generally. The vast preponderance of water in the high southern latitudes produces an uniformity in the distribution of heat throughout the year, and the more we approach the pole the more distinctly does this appear to increase. The seasons there are not distinguished, as in the north, by their temperature, but by scarcely anything more than the variation in the amount of light; all the months are cold, but the thermometer varies, as in the tropics, within narrow limits. In the

region of floating icebergs, between 55° and 65° S. lat., seldom a day occurred during the summer in which the temperature rose or sunk beyond the limits of 0° c. and — 6°·6 c. South winds, with much snow, alternate there with aerial currents from the north, which being loaded with aqueous vapour, incessantly diffuse white fogs of indescribable density over the surface of the ocean. These precipitations are also formed on islands situated in the vicinity of this region, throughout the year, by the admixture of the winds from the land and sea depriving them of their solar climate, and for the most part preventing the change of temperature dependent upon the position of the sun. A climate so inhospitable and uniform excludes any variety in the forms of plants, but confers a luxuriance of growth upon the indigenous plants, of which the arctic regions must necessarily be deprived, because their vegetation is subjected to a prolonged winter-sleep. This is so remarkably the case, that notwithstanding the differences in the climatic conditions, most of the genera and forms of the antarctic agree with those of the arctic flora in the most important points, excluding only the Auckland Islands, which appear to belong to the same primitiveformation with New Zealand. But notwithstanding this similarity of the types, the species of the southern district are peculiar; which could not have been expected to be otherwise in the case of islands, not only separated climatally to such an extent, but are also situated beyond the reach of all continents, the oceanic currents of which usually plant the waste shores. Many antarctic species indicate their endemic origin by the limited district through which they are distributed in the region itself. However, the special botanical results of Hooker's voyage, the description of which far excels his former communications in fulness and arrangement of the matter, are reserved for the next Annual Report. The Cryptogamia have also been partly described in the 'London Journal of Botany' for 1844, including 72 Hepaticæ from the Auckland Islands, by

Hooker and Taylor, (p. 366;) 66 sp. more from the Falklands, Cape Horn, and Kerguelen's Land, by the same author, (p. 454;) 73 antarctic Jungermanniæ, by Hooker and Wilson; with the new genera *Lophiodon* and *Hymenodon* (p. 533), and 151 antarctic Lichens, by Hooker and Taylor, (p. 632.)

Dr. Hooker paid particular attention to the distribution of the *Algæ* floating in the high latitudes of the Southern Ocean. (Antarct. Voy., Introduct.) *Macrocystis* and *Urvillea* were found common as far as the northern limit to the floating ice, in one instance they extended to 64° S. lat.; but they usually disappeared much sooner, e. g. south-east of America, below 55° S. lat. But in the latter meridian a new form of *Alga* appeared below 63° S. lat., which although previously found in D'Urville's expedition, has since been described as *Scytothalia Jacquinotii*. Here, near the coast of Palmer's Land, on Cockburn's Island, (64° S. lat.), no Phanerogamous plants were met with, only 20 Cryptogamia. These appear to be the last forms of plants in the direction of the antarctic pole; for even the Algæ are absent on that continental coast upon which the active volcano Erebus and the extinct volcano Terror are situated, and where the soil at the level of the sea appeared for the first time entirely deprived of vegetation,—a sight never before witnessed, and from which nature appears to have preserved even the highest latitudes of the north.

REPORT

ON THE PROGRESS OF

GEOGRAPHICAL AND SYSTEMATIC BOTANY,

DURING THE YEAR 1845.

August (Heinrich Rudolph)
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GEOGRAPHICAL AND SYSTEMATIC BOTANY.

THE consideration that the greater number of literary productions in the province of Systematic Botany are connected with the working out of individual local floras, and ought therefore to have been noticed in the preceding botanico-geographical Annual Reports, has convinced the author of them, that by altering the arrangement of the matter, with an appropriate limitation of the descriptive notices, Systematic botany also may be made to enter into these notices, without the allotted space being exceeded. The year 1845 has moreover proved comparatively poor in botanico-geographical results, so that the present period appears appropriate for a first attempt at enlarging the botanical Annual Reports in correspondence with this view. Hence by comprising, in combination with those upon Vegetable Physiology, the entire domain of Botany, they will now obtain a completeness corresponding to that of the Zoological Reports, and, as I hope, will acquire more practical utility. An important limitation will, however, still exist in the Botanical Reports, viz. that both the descriptions of the plants, as also the notices of individual species of genera already known, are excluded from the sketch given of the systematic works; not only, however, does want of space compel us to omit these considerations, but it would also be superfluous to repeat here what is annually done in so admirable a manner in several botanical periodicals and repertories.

A.—BOTANICAL GEOGRAPHY.

R. B. Hinds has continued his general observations upon botanical geography (see Annual Report for 1842) during the past year (Memoirs on Geographic Botany, Ann. Nat. Hist. vol. xv); like the former, however, they contain little more than already known facts and views, not unfrequently mingled with errors, both as regards the facts and deductions.

The present papers contain, e. g. estimates of the whole number of plants known;* remarks upon centres of creation, the existence of which the author denies; on the distribution of certain families; on the mean area of the extension of each species; elements for the comparison of two floras; on physiognomy, &c. I shall only enter upon the consideration of one of these views, and that because it places a simultaneous work by Forbes, remarkable for its originality, in a proper light. The old hypothesis of a single centre of creation, from which all plants upon the earth were distributed, as also the later supposition, that this migration of organisms originated in one or a few centres, Hinds opposes by the general law, that wherever plants met with the conditions necessary for their existence, the present vegetation was originally produced. He does not admit, in opposing every migration of plants, even such variations in the original state as would cause the extirpation of individual species, and their disappearance from among the number of living organisms; whilst such an event, e. g. in the case of the endemic plants of St. Helena, has been as satisfactorily determined as in that of *Didus ineptus.* The historical change in the constituents of forests, and the migration of individual plants which is in progress before our eyes, and is not merely produced by man, are incompatible with a law expressed so generally. The fact that certain islands in the Indian Ocean, as e. g. Darwin showed, contain only plants which have been washed on shore, by which they are thickly covered, whilst the islands in their vicinity possess an endemic vegetation, contradicts the supposition of the existence of a generally diffused productive force, or at least limits it to distinct creative epochs. When we

* Hinds estimates the number of known plants at 89,170; those existing on the earth at 134,000 species. His statements are founded upon the number of species contained in the first four volumes of De Candolle's 'Prodromus.' These amount to 20,100; of which 3875 are Leguminosæ, 1631 Rubiaceæ, 1009 Umbelliferæ, 990 Cruciferæ, 759 Caryophyllaceæ, 715 Myrtaceæ, &c.

reflect on the well-known facts which Hinds brings forward, without either certainty or accuracy of detail, as the foundation of his opinions, they leave room for the formation of other hypotheses besides his. His laws are as follows: 1. In proportion as the districts of vegetation are further separated from each other by the sea, so is the number of species of plants common to them less. Hence the large number of species common to the three large portions of the earth in the arctic zone, and hence the greater the contrast, in comparing the floras of corresponding climates, the further south we proceed, the various portions of the earth in the southern hemisphere being further separated from each other. 2. If we divide the whole earth into six floral districts—which would certainly be arbitrary enough—we obtain for each almost exclusively endemic species, and we may add, that the same result would hold good were we to admit more than thirty districts. 3. In different natural floras under corresponding climates, we certainly find similar forms, but not the same species. 4. In some islands the vegetation is entirely endemic; these cannot, therefore, have obtained their plants by migration from external sources, &c. All these and similar facts certainly are opposed to the migration of plants from a single point of the earth's surface to all the rest, and which scarcely any naturalist now believes; but there is a broad interval in the argument, which has not yet been filled up with facts, between these considerations and the assertion, that centres of creation do not exist, but that every point has produced the plants it possesses. We know that some regions of the earth contain many more endemic species than others, without the soil or climate being sufficient to explain this increase. The number of endemic forms diminish in the direction of any climatal boundary, as it were, like the radii of a circle, in the centre of which a centre of creation is situated; hence, e. g. in Europe, we may speak of western, eastern, or southern forms of plants, which gradually disappear, one after the other, towards the east, the west, or the north. There does not appear to be any other difference between an island which possessed endemic plants only, as St. Helena, and a continental district, which, like Spain or Illyria, abounds in endemic plants, than that other plants which have migrated from external sources are associated with the latter, which could not readily occur in the former case, on account of the distance of any continent. On reviewing all the known facts, and seeking for the simplest theory by which their relation may be explained, we are compelled to adopt the supposition of the existence of as many centres of creation as there are districts of endemic plants upon the globe. The difficulty of determining in each case the original centre of creation, on account of the mixture of the groups in the wide and connected districts of continents, is so great, that it must always remain the main object of botanical geography. It is only the problem of the groups of creation that gives this science a peculiar importance, and raises it above the imputation of being an aggre-

gate of heterogeneous laws belonging to different sciences; for in this light only does it present a definite and independent method of investigation, a progressive course of development. Commencing with observations upon the geographical area of each individual species of plant, the object of botanical geography is first to determine what limits to this distribution have been placed by the composition of the soil or the subdivision of the continent. It then points out the climatal sphere of the species, and if it ascertains, after this twofold limitation, that the natural area is more contracted than is accounted for, the geological problem presents itself—what has not been the result of soil and climate must depend upon historical causes, the history of the earth. If the same soil and the same climate have produced only similar but not identical forms, this refers us to a creative act of a different kind, therefore to a geological epoch.

In connexion with this combination of geological and botanico-geographical investigation, Forbes has made an attempt of a different kind, viz. the application of the distribution of plants to geological deductions (Report of the Meeting of the British Association, held at Cambridge, Ann. Nat. History, xvi, p. 126). On comparing the specific centres of the endemic plants of Great Britain, i. e. the centres of their geographical areas, it is evident that the flora of the greater part of the surface of the country belongs to that of Germany. The specific centres of the few species peculiar to the British Isles occur in the same region. In addition to this principal area, four smaller districts of vegetation may be distinguished according to the same law: 1. The mountainous districts of the west of Ireland contain a number of plants in common with the north-west of Spain and the Pyrenees. 2. The south country, Devonshire, Cornwall, and the Channel Islands, in common with the west of France. 3. The south-east of England, especially its chalky districts, with the north of France. 4. The mountains of Wales, the north of England and Scotland, with the plains of Norway. Forbes does not consider this connexion as explicable by soil and climate, and therefore seeks for geological causes, in conformity with the above law. He believes that these are to be found in a former connexion of Great Britain with the continent, probably existing in earlier geological periods, especially during the tertiary period: not that this connexion, made use of for his explanation, has been geologically determined; but he endeavours to support his geological hypotheses by these botanico-geographical relations. Following up this design, which is certainly not free from objection, Forbes then not only maintains generally these connexions of land, but by supposing former elevations and subsidence of the soil, arrives at certain views regarding the series of changes which have occurred; in fact, he distinguishes the floras according to the periods at which they were formed. I should have no hesitation myself in granting, that when two different floras really belong to the same soil and climate, by far the simplest hypothesis is to attribute their origin to

different geological epochs; but if, as I believe to be the case, climatal conditions sufficient to account for the above distribution of British plants were present, the error would not lie in the method, but its application, which has led Forbes to the following results. According to his view, the districts of vegetation distinguished above correspond to as many geological eras, so that the flora of the west of Ireland would be the oldest, that of the mountains the fourth, and that related to Germany the youngest. The first mentioned descend from a time when a chain of mountains, running across the Atlantic Ocean, connected Ireland with Spain; this would explain its difference from the vegetation of the mountains, although it would still correspond with the mountain character. Moreover, in the second and third periods the English Channel was closed, first towards the west, then towards the east also, by the connexion of land, and thus the distribution of French plants in England was occasioned. Forbes explains the alpine flora of the mountains by means of Agassiz's glacial period; the mountain summits of Britain were then low islands, extending to Norway, and were clothed with an arctic vegetation, which, after the gradual upheaval and consequent change of climate, became limited to the summits of the newly-formed and still existing mountains. Lastly, the bed of the North Sea itself was upheaved, and extensive plains laid dry between England and Germany, upon which the elk and other extinct quadrupeds lived, and over which the plants of Germany migrated; until at last the sea, in consequence of fresh depression, flowed back, after the important object of transplanting Roses and *Rubi* beyond the ocean had been accomplished. Further than this, hypothetical views could not easily be carried, and I have translated them almost entirely here, only because Forbes appears desirous by this paper of opening a new path in botanical geography, for this first lecture has since been followed by others. The criticism of his undertaking lies simply in the denial of one of the first statements with which he commences: actual natural forces, the sea, rivers, currents of air, by which seeds are diffused, or animals, and even man, are, in the majority of cases, insufficient means for effecting the migration of plants across the British seas. I maintain that these forces are quite sufficient, provided the imported seeds meet with a suitable climate and proper soil. Those western-Europe plants,—which, being produced through the agency of the coast-climate of the Atlantic, and, according to the degree of this dependence, becoming distributed sometimes to a greater, sometimes a less distance within the continent, the author refers in the latter case to Spain, in the former to France,—are not met with equally on the coast-line of the continent, but are often absent from wide tracts, the soil of which is not favorable to their growth; when e. g. we do not find *Erica cinerea* anywhere from the Rhine to the Fjord of Bergen, who would, in this case, suppose that former connexions of land had disappeared, when for the most part the connexion still exists, without contributing to the distribution of this shrub?

Since the Alps contain so many alpine species in common with the arctic regions, it is still more easily seen how little the continent situated between these two terminal points serves to explain these agreements. The plains which, without this alpine attire, extend e. g. from Cola to the Carpathians, are, however, less adapted to the transport of foreign plants than a sea which rapidly carries over the seeds in its current. Or when Forbes has recourse to the glacial period in explaining the diffusion of the arctic plants: how will he account for so many central European species of Sierra Nevada or Pindus traversing the extensive tracts of land which separate them from their centre of creation? How, by the most complex dislocations, will he bring the *Minuartiæ* and *Queriæ* into geological connexion, which do not flourish anywhere between Castile and the Crimea? There is no reason why water should form a greater obstacle to the distribution of plants than a soil which does not conduct them; extensive oceans certainly form barriers, when there is no current to carry them across, or when the climates of the two coasts are dissimilar.

A. Erman has written a paper on the periods of vegetation in different climates (Arch. für Russland, Bd. 5, pp. 617-40).

He examines the question, of what relation the stages of development of vegetation hold to the temperature, at which in different latitudes they appear in the same species. His investigations lead to the negative result, that a law communicated to him conjecturally by Quetelet is unfounded. It consisted in the assumption that similar stages of development occur in two different places, when the sum of the squares of the diurnal temperature from the commencement of the period of vegetation is the same for both. He shows, also, that the stages of development and the sum of the temperature acting upon them in different places, are by no means in direct proportion.

We must mention a remark made by J. D. Hooker in regard to botanico-geographical physiognomy (On *Fitchia*, in Lond. Journ. of Bot., 1845, p. 640).

On many remote islands possessing endemic floras, we find woody plants belonging to the family of Synantheraceæ, which contribute essentially to the character of the districts, and belong to peculiar genera, of which representatives do not occur on the continents. The following sketch will serve to illustrate this:

St. Helena contains 4 gen. 10 sp. of Synantheraceæ, all woody plants;
Juan Fernandez „ 8 „ 17 „ of „ of which 3 gen. and 12 sp. are woody plants;
Gallapagos contains 13 gen. 21 sp. of Synantheraceæ, of which 3 gen. and 8 sp. are woody plants;
New Zealand contains 30 gen. 60 sp. of Synantheraceæ, of which 8 gen. and 14 sp. are woody plants.

Elizabeth Island, which belongs to the botanical district of the South Sea Islands, in the southern hemisphere, but is situated nearer to the island of Juan Fernandez and the continent of America than the others, also contains the new arborescent Cichoraceous genus, *Fitchia*, whilst the other islands of this archipelago do not contain similar forms of plants.

I.—EUROPE.

Of Ledebour's Flora Rossica (see the Annual Report for 1841 and 1843), the 6th part appeared in 1845, and the 7th in 1846 (vol. ii, part 2).

The statistical proportions of the families treated of in them are as follows: Synantheraceæ, 890 sp. The Vernoniaceæ are only represented by the Caucasian *Gundelia;* of the Eupatoriæ, in addition to the West-European genera, *Nardosmia* and 7 arctic species; the Asteroideæ comprise the exclusively Asiatic genera *Turczaninowia, Calimeris, Arctogeron, Diplopappus, Rhinactina, Myriactis, Brachyactis, Dicrocephala, Karelinia, Eclipta,* and *Siegesbeckia,* which extends as far as the Crimea; among the Senecionidæ, including the Heleniæ, *Richteria* and *Cancrinia, Brachanthemum,* one of the Chrysanthemeæ from Siberia, *Waldheimia* from Altai, *Cladochæta* and *Amblyocarpum* from the Caucasus, and *Senecillis* from Podopolien. The genera most abundant in species are *Artemisia* (83 sp.), *Senecio* (52 sp.), *Achillea* (31 sp.), *Pyrethrum* (29 sp.); among the Cynaraceæ, including *Acanthocephalus* and *Haplotaxis* (3 sp.), and *Ancathia* from Altai, *Alfredia* (4 sp.) from Siberia, and *Cousinia* (20 sp.) and *Acroptilon* from the Steppes, and *Acantholepis, Chordinia,* and *Oligochæta* from Armenia. Those containing most species are *Centaurea* (61 sp.), *Cirsium* (51 sp.), *Serratula* with *Jurinea* (36 sp.), *Saussuria* (32 sp.); the Cichoraceæ contain *Heteracia* and *Microrhynchus* from the Steppes, *Asterothrix* from the Caucasus, *Intybellia* from the Crimea, *Youngia* (5 sp.) from Armenia and Siberia, *Ixeris* and *Nabalus* from Siberia, *Apargidium* from Sitcha; and of larger genera, *Hieracium* (25 sp.), *Crepis* (23 sp.), *Scorzonera* (19 sp.), *Lactuca* (17 sp.), *Tragopogon* (17 sp.); Lobeliaceæ, 2 sp.; *L. dortmanna,* and in Eastern Siberia *L. sessilifolia;* Campanulaceæ, 66 sp., containing *Michauxia* and *Symphyandra* from the Caucasus, *Platycodon* from Darien; the genera containing most species being *Campanula* (36 sp.) and *Adenophora* (10 sp.); Vacciniæ, 11 sp., including 4 sp. from Sitcha, 1 sp. from the Aleutian Islands, and *V. arctostaphylos* from the Caucasus; Ericeæ, 36 sp.; 2 *Rhododendra* and *Azalea Pontica,* confined to the Caucasus, extending hence to Dombrowitza in Lithuania, 4 sp. of *Cassiope, Bryanthus,* 2 sp. of *Amothamnus,* 5 sp. of *Rhododendron* confined to Siberia, 2 sp. of *Cassiope, Menziesia,* 1 sp. of

Phyllodoce, Kalmia, and *Cladothamnus* confined to Sitcha; Pyroleæ, 7 sp., corresponding to the German species; Monotropeæ, 1 sp.

The 5th and 6th parts of Trautvetter's illustrated work 'Plantarum imagines Floram Rossicam illustrantes.' Monachii, 1845, 4to, (see the preceding Annual Report) have appeared, containing pl. XXI—XXX.

The Academy of St. Petersburg has commenced the publication of 'Contributions to the Botany of the Empire of Russia' (Part 1, Petersburg, 1844, 30 pages 8vo.; part 2, 67 pages and 6 plates; part 3, 56 pages; part 4, 93 pages; ib. 1845).

The first part contains a local flora of the province of Tambow (incomplete, containing 312 sp.), forming Ruprecht's fourth contribution to the flora of St. Petersburg. The same author has published an account of the Ferns and Charæ of the empire of Russia in the third part; it also describes some new Ferns from Siberia, Mongolia, and American Russia, as also of the Charæ from the Soongari.

The second part, in which Ruprecht has described his botanical travels in the extreme north of European Russia, is of more general interest. In the unfavorable summer of the year 1841, he collected in the eastern part of the province of Archangel, especially Mezen, the peninsula of Kanin, and the island of Kalujew. The natural character of the country differs from that of Scandinavian Lapland in the circumstance that the forest-limit recedes almost to the vicinity of the arctic circle; hence extensive, low, treeless plains are spread along the arctic ocean. Thus the pine forests are entirely absent at Kanin (excepting a wood composed of *Abies*, situated below 67¼° N. lat., and which is now dying); they cease at the Indega river, about fifteen English miles from the sea, and scarcely extend over the arctic circle beyond Petschora. The cultivation of barley and potatoes also is only carried on as far as the city of Mezen. The forests are succeeded northwards, first by a zone of low birches and willow-shrubs, the dwarf birch with the arctic Ericaceæ follow next, and lastly, with the latter the continuous turf of the alpine regions terminates. A few Ranunculaceæ, Saxifrageæ, and Grasses, which only partially cover the soil, are all that are subsequently met with. In these travels 342 Phanerogamic plants altogether were collected. They also differ from those of the flora of Scandinavian Lapland, in containing a large proportion of species which are not Scandinavian. Eleven new species, which are illustrated by figures, belong to the genera *Ranunculus, Viola, Parnassia, Salix*, and *Poa* (7 sp., 1 sp. of each of the others).

Czerniaïew has published some scattered remarks on

the influence of climate upon the vegetation of Ukraine, at the same time introducing the description of some new Fungi (Bulletin des Naturalistes de Moscou, tom. xviii, part 2, pp. 132-57).

Many plants are excluded by the low Isochimena, whilst the high summer temperature appears favorable to the culture of Maize and several Cucurbitaceæ, by which also the author endeavours to explain the remarkable fact, that the berries of *Solanum nigrum* in Ukraine lose their narcotic principle, and when ripe become saccharine and eatable. The forests and fields there are protected from the persistent aridity of the summer, which acts to so great a degree upon the adjacent steppes, by the soil of humus, which is from 10 to 15 feet in depth (Tscherno Sem; compare Ann. Rep. for 1843.) Hence the principal forest trees which thrive there are such as send out deep roots, as the oak, the lime, elms, and pear trees; the red fir (*P. Abies*), which predominates on the shallow soil of Scandinavia, is unknown in Ukraine, and the ash is frequently killed during the dry season. The deep soil of humus causes several herbaceous plants to grow there to an unusual height; *Cephalaria Tartarica* is found 9 feet, *Delphinium elatum* 5—6 feet in height; Thistles and Umbelliferæ are usually twice the size of those of other regions; of the Fungi, the pileus of *Polyporus* and *Leuzites* is found three feet in breadth; and the new *Morchella alba* a foot in height. But the most remarkable object presented by this luxuriant development is the new Bovista, *Lycoperdon horrendum*, a spherical Fungus, 3 feet in diameter. This Fungus, says the author, might really produce no slight amount of terror; when in the dark forest it suddenly comes into sight, it makes one imagine a phantom in white or brown garments and in a stooping attitude. This black earth of the south of Russia, which produces this luxuriant growth, must indeed contain a large store of nutritive matter for the vegetable world; for barley grows there as in the best districts of England or Germany, without ever requiring manure. As regards the Fungi of Ukraine, Czerniaïew attributes the very numerous varieties of their forms to the paucity of the species of Mosses, Lichens, and Ferns. According to his observations, Ukraine alone contains more than 1000 Hymenomycetæ, whilst the abundance of Gasteromycetes is still more characteristic. Weinmann, in his 'Prodromus,' which was published in 1836, enumerates 300 Gasteromycetes as existing in the whole of Russia, whilst Czerniaïew has found almost twice this number of species in Ukraine alone: among them there are several new forms, and a few new genera.

Weinmann has studied the Mosses of Russia (Bulletin Moscou, tom. xviii, pt. i, pp. 409-89, and pt. ii, pp. 417-503); his new species belong to *Funaria* (1 sp.) and *Hypnum* (4 sp.) Kaleniczenko describes ten new plants from the south of Russia and the Caucasus (Ibid. pt. i, pp. 229-40);

2 Umbelliferæ (*Pimpinella* and *Pastinaca*), 2 Leguminosæ (*Arthrolobium*), 6 Synantheraceæ (*Inula*, 2 sp., *Centaurea*, 3 sp., and *Jurinea*).

The travels of A. Bravais and Ch. Martins (Bibliothèque univers. de Genève, 1845, vol. ii, pp. 147-73) traverse the north of Scandinavia almost exactly in the same way as that described by V. Buch in his celebrated work on the extreme regions of the north, when he returned from Alten-Fjord, in Finmark, to Tourneå, on the Gulf of Bothnia. But the French travellers believe that they have measured the limits of vegetation under more favorable circumstances; hence their results must find a place here. They completed the difficult journey from the 6th to the 26th of September, 1839: remarking at the same time, that partly on account of the water which they had to pass over, partly on account of the swarms of gnats met with in Lapland during the summer, which have to be avoided, September is the only month fit for travelling.

In the forests of Alten (70° N. lat.), the pines were 60′ in height, the birch on an average 45′. On the third day they passed over the upper terrace of the plateau of Kjölen. Under the name of Nuppivara, it ascends here to an elevation of only 600 metres; but it is of the same conformation as the far more elevated, undulating plateaux of the Langfjelde, which abound in lakes. The bare soil of the rocks contains only a scanty underwood of *Betula nana* with *Empetrum*, and *Andromeda tetragona*, or *Salix Lapponum* with *Juniperus communis*. On the south side, birch forests are again next met with, but they do not extend above Kautokeino further than to Karesuando (68° 36′); for from this point the whole country, as far as the Gulf of Bothnia, is covered with a single continuous pine forest.

Limits of vegetation measured:

Northern slope of Kjölen, in the valley of Alten.

Pinus sylvestris, dense forest	249 metres
„ isolated dwarf	500 „
Betula pubescens, dense forest	380 „
„ in the form of a stunted tree	432 „
„ „ local	534 „

Southern slope of the Nuppivara.

Betula pubescens . . . . . . 477 m., 480 m.

(The figures in apposition denote the results of different measurements.)

Sorbus Aucuparia . . . . 477 m.

Dividing line between the rivers of the North Sea and of the Baltic: Region extending from Kalanito to Suvajervi.

Pinus sylvestris	341 m., 374 m.
Betula pubescens	493 m., 498 m., 520 m., 530 m.
Sorbus Aucuparia	474 m.

At Karesuando.

Pinus sylvestris	410 m.

A list of the Phanerogamous plants occurring at Karesuando, by Læstadius, is inserted in the report of these travels.

A report by Blytt on his botanical journey through the valley of Valders in Norway, contains, for the most part, merely copious lists of localities (Bot. Notiser, 1845, Nr. 1-3). The author, however, in his account of the calcareous vegetation of Torpe, adds some remarks upon the influence of lime on the distribution of Norwegian plants.

Very few peculiarly calcareous plants are found there, and several species which in other countries are confined to a calcareous soil, grow upon the gneiss-formations of Norway. Blytt only enumerates the following Phanerogamia as belonging to the chalk in Norway: *Anemone ranunculoides*, *Trifolium montanum**, *Libanotis**, *Monotropa*, *Stachys arvensis*, *Carduus acanthoides**, *Ophrys myodes**, *Neottia nidus avis*, and *Malaxis Loeselii*; those species only marked with an * are, according to my knowledge, peculiar to calcareous soils in other regions, nor are the Lichens and Mosses enumerated, so in every case. Blytt then criticises Unger's well-known catalogue of lime-plants, and in so doing, he separates the following species, which grow in Norway on the gneiss-formation, and part of them on it only: *Hepatica triloba*, *Corydalis fabacea*, *Astragalus glycyphyllus*, *Dryas*, *Rubus saxatilis*, *Sorbus aria*, *Cotoneaster vulgaris*, *Saxifraga oppositifolia*, *Asperula odorata*, *Pyrola rotundifolia*, *Arctostaphylos alpina*, *Fagus*, *Taxus*, *Convallaria majalis*, *verticillata*, *Polygonatum*, *Calamogrostis sylvatica*, and *Brachypodium gracile*.—*Grimmia apocarpa*, *Hypnum Halleri*, *Lecidea vesicularis* and *candida*, and *Gyalecta cupularis*.

Blytt points out similar differences between Norway and Tyrol, in regard to those plants which, according to Unger, are more common on a calcareous soil on the Alps than upon other substrata.

W. P. Schimper has given a description of the Dovrefjeld, especially the Mosses found on it, several new species even of which he has discovered on this soil, which has been so frequently described (Ratisbon Flora, 1845, pp. 113-28.)

Swedish works upon the botanical topography of Scandinavia: Anderson, Plantæ vasculares circa Quickjock Lapponiæ lulensis (Upsal, 1845, 8vo, 36 pages); contains 356 sp.; Lagerheim and Sjögren, Botanical Remarks made during a journey from Stockholm to Snaasahög in Jemtland, in 1844 (Bot. Notiser, 1845, Nr. 11); Schagerström, Conspectus vegetationis Uplandicæ (Upsal, 1845, 8vo, 83 pages): contains 870 sp.; Lindeberg, an Excursion to the Malar Lake (Bot. Notiser, 1845, Nr. 12); Lindgren, Notices upon the Vegetation of the Wener Lake (ibid.), with a description of some new pileate Fungi; Lindeberg, on the Country around Grenna on the Wetter Lake (ibid. Nr. 4).—Systematic contributions to the Flora of Sweden: Anderson, Salices Lapponiæ, cum figuris 28 specierum (Upsal, 1845, 8vo, 90 pages): described according to Fries's views; Lund, Conspectus Hymenomycetum circa Holmiam crescentium (Christiania, 1845, 8vo, 118 pages).

On the botanical topography of Denmark: Petit, Remarks on the Vegetation of the south-west of Zealand (Kröyer's naturhistor. Tidskr., second series, vol. i); J. Lange, on the Vegetation of Laaland and Falster (ibid.) In the case of a tolerably large number of the plants mentioned here, the north limit to their distribution is situated on these islands.

Watson is preparing some new works on the botanical geography of Great Britain, and has made a report upon the plan adopted in them (Lond. Journ. of Bot. 1845, pp. 199-208). He very properly takes care to separate the topographical details of the localities from the more general investigations, which are of real scientific interest. The two botanical regions which he distinguishes in Great Britain, he denominates the Agrarian and the Arctic; the area of the region of the Cerealia coincides with the distribution of *Pteris aquilina*.

Further contributions to the botanical topography of Great Britain: Balfour, on some Excursions on the Scottish Peninsula of Cantire, and the Island of Isla, one of the Hebrides (Ann. Nat. Hist. xv, pp. 425-6); Gardiner, on

the Highlands of Braemar (Botanical Rambles in Braemar, Dundee, 1844), described in a picturesque style; Moore, on the rare Plants of Yorkshire (Report of the British Association held at York, pp. 70-1); Andrews,on the Island of Arran and the West Coast of Ireland (Lond. Journ. of Bot. 1845, pp. 569-70).

Local British Floras: On the county of Cork in Ireland (The Botanist's Guide for the County of Cork: Contributions towards a Fauna and Flora of the county of Cork, London, 1845, 8vo), contains 885 Phanerogamia, and 936 Cryptogamia; Jenner, on the country around Tunbridge Wells, in Kent (A Flora of Tunbridge Wells; Tunbr., 1845, 8vo), includes also the Cryptogamia.

Systematic works on British plants: Bell Salter, three new species of *Rubus* (Ann. Nat. Hist. xv, p. 305); Babington on *Cuscuta* (ibid. xvi, pp. 1-3), containing figures of *C. trifolii* and *C. approximata* Bab., the latter brought over from the East Indies, with seeds of *Melilotus;* Parnell, on the Grasses (Descriptions of the Grasses of Great Britain, illustrated by 210 figures); Spruce, on some newly-discovered Mosses (Lond. Journ. of Bot., 1845, pp. 169-95); 23 Jungermanniæ with 4 new species; Taylor, on 6 Jungermanniæ new to great Britain, (ibid. pp. 276-8,) amongst them one new species; Salwey, the rare Lichens of Wales (Ann. Nat. Hist., xvi, pp. 90-9); Hassall, a History of the British Fresh-water Algæ, including the Desmideæ and Diatomaceæ, with upwards of 100 plates (London, 1845, 2 vols. 8vo). The Phytologist is continued. The following collections of dried plants must be mentioned: Salicetum Britannicum auct. Leefe (see Ann. Rep. for 1843), fasc. 2, see the critical remarks by Sonder (in Ann. Nat. Hist. xv, p. 275); M'Calla, Algæ Hibernicæ, vol. i (Dublin, 1845, 4to), with 50 species; Ayres, Mycologia Britannica (London, 1844), containing 50 sp., may be regarded as a continuation of Berkeley's work.

Van den Bosch has published the third part of his Flora of Zealand (see Ann. Rep. for 1842), containing

the Lichens and some additions (V. d. Hoeven, Tydschrift, vol. xii, pp. 1-22), e. g. in the coast districts of the Netherlands: *Cerastium tetrandrum*, *Trifolium subterraneum*, and *Centaurea nigra*, are found common, also *Salix holosericea*, *Carex trinervis* (*C. rigida* Fl. Leydens), and *Zygodon viridissimus*. The contributions to the Cryptogamic Flora of the Netherlands, by Dozy and Molkenboer, have been continued (ibid. pp. 257-88): on the Fungi, containing among them some new species which are illustrated by figures. General works on the Flora of Germany: Reichenbach's Icones, vol. vii, Dec. 5-10, with the Naiadeæ, Alismaceæ, Hydrocharidaceæ, Nymphæaceæ, and a supplement to the Grasses; Sturm's Flora, sect. 1, parts 89, 90, principally containing species of *Viola* and Labiatæ; V. Schlechtendal and Schenk's illustrated work, vol. vi; Lincke's Publication, parts 50-9; Koch's synopsis, ed. 2, fasc. 3 (Lips. 1845), containing the Ferns, with appendices and the Index: an abridgment of this work appeared as a pirated edition under the false name of Herold; Nees v. Esenbeck's Genera Plantarum Floræ Germanicæ, continued by Putterlick and Endlicher, fasc. 24 (Bonn, 1845, 8vo). Special systematic works on the Flora of Germany: Sauter's new Contributions to the Flora of Germany (Ratisbon Flora, 1845, pp. 129-32): unimportant notices, with the diagnosis of a new *Riccia*; Perktold, the *Hypna* of Tyrol (Neue Zeitschr. des Ferdinandeums, Bd. 11); Rabenhorst's Cryptogamic Flora of Germany (see the preceding Ann. Rep.) vol. ii. pt. 1, containing the Lichens; Roemer, the Algæ of Germany (Hanover, 1845, 4to; with 11 plates), confined to the fresh-water Algæ, principally the forms found by the author on the upper Hartz, and imperfectly illustrated by bad lithographic drawings; arranged according to Kützing's system, but paying no attention to the history of development; Kützing's Phycologia Germanica (Nordhausen, 1845, 8vo). It includes the entire flora, and only appeared a few weeks after the preceding work, Roemer's materials having been made use of; yet it is carried out perfectly

independently of these, and although subject to known criticisms in a systematic point of view, is indispensable to the understanding of the author's larger work on the Algæ.

Local Floras of Germany: F. Wimmer, Flora of Silesia. Concluding volume (Breslau, 1845, 12mo); J. C. Metsch, Flora Hennebergica, a contribution to the Flora of the Prussian portion of the Forest of Thuringia (Schleusing, 1845, 8vo); F. Schultz, Flora of Palatinate (Speier, 1846, 8vo); it appeared, however, in 1845.

In Metsch's memoir upon the plants of the mouth of the Swine (Ratisbon Flora, 1845, pp. 705-8) is contained a sketch of the vegetable formations on the island of Usedom.

The sandy soil is in some places extended into plains, at others depressed, so as to receive deposits of peat or salt-water lakes; sometimes it forms elevations, which are partly covered with the pines, or even considerable forests of beech. The dunes along the coast are consolidated by roots of Glumaceæ or *Salix*. A few of the characteristic plants only can be mentioned here, as the author only enumerates the more rare species:

1. Formation of plants on the dunes, e. g. *Ammophila arenaria* and *Baltica, Elymus arenarius, Carex arenaria, Kochia hirsuta, Halimus portulacoides, Petasites spurius*, and *Anthyllis maritima*.

2. Formation of the sea plants, e. g. *Aster salignus, Erythræa linariifolia, Zannichellia pedicellata, Juncus balticus, Scirpus Rothii*, and *Hierochloa borealis*.

3. Formation of the marsh plants, e. g. *Thalictrum aquilegifolium, Barbarea stricta, Helosciadium inundatum, Lysimachia thyrsiflora, Euphorbia palustris, Salix daphnoides* and *rosmarinifolia, Stratiotes, Carex filiformis*, and *Calamagrostis stricta*.

4. Formation of the peat plants, e. g. *Ledum palustre, Betula fruticosa, Empetrum*, and *Myosotis sparsiflora*.

5. Formation of herbaceous plants on sunny hills, e. g. *Thalictrum minus* and *simplex, Silene viscosa*, and *Ononis hircina*.

6. Formation of the forests, e. g. *Arabis arenosa, Vicia villosa, Peucedanum Oreoselinum, Arctostaphylos officinalis, Pyrola chlorantha, media*, and *umbellata*, and *Goodyera repens*.

V. Mohl has written a memoir on the Flora of Wurtemberg (Würtemb. naturwissenschaftliche Jahreshefte. Jahrg. i, pp. 69-109. Stutt., 1845, 8vo).

He commences with general remarks on the scientific importance of local

floras. He states their object to consist in the investigation of the limits of the distribution of the species within a larger district, and for this purpose to compare them, as e. g. the flora of Wurtemberg with that of the adjacent countries. In this manner he shows, that when a natural subdivision of Germany is made, the flora of Wurtemberg belongs to those of the adjacent districts, and does not contain distinct centres of vegetation of its own. Mohl distinguishes four separate regions : the fluviatile system of the Neckar and the Tauber, the Black Forest, the rugged Alp, and the tertiary plain of Upper Swabia.

1. The Neckar region, lying between the Swabian Jura and the Black Forest, in regard to the distribution of its plants, may be considered as a portion of the Rhine district. The eastern limit to the occurrence of a tolerable number of plants exists at the Jura; but with the single exception of *Orobus albus* (at Tübingen), no species is found from the Neckar to the Tauber, which does not also exist in the valley of the Rhine. But the district on this side is poor in comparison to the latter; for "in correspondence with a general phenomenon," as the bed of a river becomes narrowed, many plants disappear which are common lower down the stream. The author also gives a list of more than fifty species which prove this connexion, and from which we shall select the following as characteristic forms of the Rhine district: *Helianthemum œlandicum* (*vineale*), *Myagrum perfoliatum*, *Isatis tinctoria*, *Diplotaxis tenuifolia* and *muralis*, *Althæa hirsuta*, *Lathyrus hirsutus*, *Rosa gallica*, *Helosciadium nodiflorum*, *Œnanthe peucedanifolia*, *Carum bulbocastanum*, *Crepis pulchra*, *Lactuca saligna*, *Artemisia pontica*, *Centaurea nigra*, *Heliotropium Europæum*, *Calamintha officinalis*, *Mentha rotundifolia*, *Parietaria diffusa*, *Spiranthes æstivalis*, and *Scirpus mucronatus*. Geologically considered, the district of the Neckar and the Tauber belongs to the muschel-kalk, lias, and the keuper formations. Of these, the muschel-kalk, as in Thuringia, exerts the most important influence upon the distribution of the plants, whilst the lias and keuper, being less homogeneous formations, favour a greater chemical variation in the soil. A list of about 20 sand-plants contrasted with 100 plants belonging to the muschel-kalk, shows how the latter augments the number of indigenous species to a greater extent than the other formations.

2. The Black Forest, the soil of which is derived from *bunter* sandstone or Plutonic rocks, contains in the district of Wurtemberg but few Phanerogamia peculiar to it, whilst the higher elevations of these mountains, which are also poor in plants, belong to Baden. Among the plants of the Black Forest of Wurtemberg, excepting those which also occur in other regions of the kingdom, there is not one which is not distributed over the greater part of the mountains of Germany, so that e. g. all those mentioned, excluding *Crocus vernus*, occur also on the Hartz. If we bring into relation with these facts Kirschleger's general remarks upon the whole of the Black Forest (see

Ann. Rep. for 1843), we cannot enumerate these mountains among the independent centres of vegetation of the flora of Germany, because the whole of their Phanerogamia may be regarded as having migrated from the Alps, the Vosges, the Jura, or the Rhenish mountains.

3. The rugged Alp (Swabian Jura) possesses the characteristic vegetation of the Jura-limestone, which is uniformly distributed from Switzerland to Franconia. However, although the mean level of the elevated surface amounts to more than 2000′, and individual summits ascend to more than 3000′, the alpine forms of plants, which are common on the higher Jura of Switzerland, are for the most part absent here, and even the few species (7 sp.) which belong to this category, are in most cases found at single spots only; whilst on the other hand, many calcareous plants from the valleys of the Bavarian Alps are common here. About 50 species are found in Wurtemberg on the rugged Alp only, 34 calcareous plants occur in common with the region of the Neckar, 18 species with Upper Swabia only, 16 others with both these districts, and 5 with the Black Forest. Perhaps the following from the list of plants peculiar to the Swabian Jura might be mentioned as characteristic forms, omitting those which are diffused over the calcareous Alps: *Thalictrum galioides*, *Thlaspi montanum*, *Sisymbrium austriacum*, *Erysimum crepidifolium* and *odoratum*, *Dianthus cæsius*, *Linum flavum* (at Ulm), *Coronilla montana* and *vaginalis*, *Sorbus latifolia*, *Leontodon incanum*, *Doronicum Pardalianches*, *Jasione perennis*, *Specularia hybrida*, *Digitalis lutea*, *Nepeta nuda*, *Orchis pallens*, *Aceras anthropophora*, and *Iris Germanica*.

4. The tertiary plain of Upper Swabia lying between the Jura and the Alps, 1250′ to 2000′ above the level of the sea, is geographically a portion of the plateau of Upper Bavaria, and also contains its vegetation, whilst the Jura agrees with it far less than might have been expected. Even the peat-moor formation is the same here as in the bogs of Bavaria. Upper Swabia, although it has been least explored botanically, probably contains more plants than any other part of Wurtemberg, on account of its fertile calcareous Molasse-soil, the considerable variations of its elevation, the abundance of water, and the proximity of the Alps from which, as in Bavaria, many plants are washed down.—The list of those plants of Upper Swabia which have not hitherto been observed in other parts of Wurtemberg, includes about 90 species.

The following from among them, excluding the alpine plants, may be mentioned as characteristic: *Ceratocephalus falcatus*, *Viola lactea*, *Linum viscosum*, *Alsine stricta*, *Potentilla norvegica*, *Saxifraga Hirculus*, *Helosciadium repens*, *Gentiana utricularis*, *Pedicularis sceptrum*, *Primula acaulis*, *Betula humilis*, *Stratiotes*, *Iris graminea*, *Allium suaveolens*, *Juncus tenuis*, *Carex capitata*, *microglochin*, *chordorrhiza*, *cyperoides*, and *Heleonastes*.

Mohl makes some ingenious observations on the distribution of alpine plants towards the Bavarian plateau of Upper Swabia. He distinguishes

several kinds of distribution: 1. The seeds are constantly being carried down anew by the waters, and the individuals which germinate are, therefore, only accidental inhabitants of the drift on the banks, not having any fixed locality, e. g. on the Iller. *Campanula cæspitosa, Hutchinsia alpina*, &c. 2. Other alpine plants, which also grow upon the Alps themselves, on the drift of the rivers, again meet with the conditions necessary for their existence in the elevated plains: hence they constitute a permanent formation there, e. g. *Myricaria, Salix daphnoides*, and *Epilobium rosmarinifolium*. 3. Other plants of the alpine flora occur in the plain of the peat-moors, far distant from the present alpine rivers, distributed socially, e. g. *Bartsia alpina, Primula auricula, Gentiana acaulis*, in large masses on the bogs of Upper Bavaria, and *Veratrum album* also in Upper Swabia. On the Alps, part of these plants grow in totally different localities; yet, according to the opinion of the author, there is no doubt that, like those above mentioned, they emanated from the Alps, although the conditions under which these depositions occurred cannot now be ascertained. In this respect, he declares that Zuccarini's view is a very hazardous hypothesis, who supposes that the first seeds were carried down in remote ages by the same rivers which filled up the whole of the tertiary plain with alpine Molasse, and gave rise to the continent. This view is inadmissible, because the phenomenon of the occurrence of the alpine plants in the peat-moors is evidently the same as that which is now going on in the north of Germany, where e. g. *Primula farinosa, Swertia perennis*, and *Salix daphnoides* are met with under the same conditions. The humous pasture-soil of the Alps is not so entirely different from peat, nor the climate of Upper Bavaria so very different from that of Mecklenberg, as regards many plants, as to render inadmissible every explanation of this simultaneous growth of individual species in remote plains and on the mountains, by means of the soil and climate: we need not then hypothetically devise any geological causes. Are not aerial currents sufficient to convey the minute seeds of the Gentianeæ, or the cotton of a willow, to all those parts of Germany, nay, even of Europe, where the climate and soil permit their germination and growth? What their original locality was, whether a plain or a mountain, appears to me an idle question, because it is incapable of scientific solution. 4. The same applies to all those alpine plants which have attained any extent of diffusion in the south-east corner of Upper Swabia, e. g. *Rhododendron ferrugineum, Campanula barbata, Streptopus amplexifolius*, &c. Mohl considers that these are the original plants of Upper Swabia, and that their origin is not to be looked for in the Alps; this view will appear totally untenable to every one who is acquainted with the botanical relations of the Alps, from personal observation, although we are not in a condition to ascertain how they arrived at their present locality. The latter point appears simple to me, when we recollect that the greater number of these plants thrive also on the Sudeten and other remote mountains, and thus probably

possess a wide climatic sphere, and also means of more easy diffusion by the air; but how the first question can be decided by personal observation, I do not understand, inasmuch as a plant may be diffused equally as luxuriantly and generally on a secondary as on a primary locality, as e. g. the thistle of the Pampas of Buenos Ayres teaches us, which in the Old World, where it is indigenous, is found at individual spots only, whilst in the former place it covers the plains in the most intimate community. The conclusion of this important work is formed by a catalogue of the names of all the Phanerogamia hitherto found in Wurtemberg, without the localities; it contains only 1287 species, i. e. more than 100 species less than are known (according to my manuscript) in the kingdom of Hanover: hence Mohl appears to be justified in the opinion, that many remain to be discovered in Wurtemberg.

The Topography of the Upper Pinzgau (see Ann. Rep. for 1840), contains a work by A. Sauter, with which I am only at present acquainted from Beilschmied's Abstract (Ratisbon Flora, 1845, pp. 501-7), upon the botanico-geographical relations of this district, which includes the longitudinal valley of the upper Salzach, between the Tauern and the clay-slate alps of Kitzbühl.

It contains, in addition to lists of the more rare species, a sketch of the botanical regions, but the source of the altitudes given is not stated. 1. Region of the cultivated country. 2400′—4000′ on the south side, —3000′ on the north side of the mountain. Pasture land alternates there with forests; meadows and fields are more rare. Most of the deciduous trees, and *Alnus incana* is very common, do not ascend higher. 2. Forest region.—On the average 3500′—5500′. *Pinus abies*, however, which constitutes the main part, appears only to thrive as high as 5000′, *P. Picea* at 4000′, whilst *P. Cembra* here and there covers the upper slopes, and in the Tauern chain ascends as high as 6000′, the same height as *P. Larix*. 3. Alpine Region.—On the average, 5503′—8000′. It also contains but few meadow surfaces, mostly naked rocks and detritus. The sub-alpine forests do not form a dense zone there; *Rhododendron ferrugineum* occurs in groups as far as 6000′; dwarf willows, *Empetrum*, *Arctostaphylos*, and *Azalea procumbens*, as far as 7000′.

Perini read a paper on the Botanical Regions of Trient, in the south of Tyrol, before the Association of Italian Naturalists (Atti di VI riunione, p. 460).

L. v. Heufler has described a botanical excursion in the north of Istria (Die Golazberge in der Tschitscherei. Triest, 1845, 4to).

On the 16th of June the author collected 300 species of plants on a mountain-ridge of the Karst, only 3410′ in height, to the south of the Fiummean road; they are enumerated in the order of their occurrence in this luxuriously-printed work. In the map which is appended, the following regions of the coast-country of Illyria, in the direction from the Adriatic Sea to the coast of Terglou, are distinguished, but how the altitudes were determined is not stated: 1, 0′—500′; region of Olives. 2, —2000′; oak-region (with regard to which it is incorrect to state that the region of the species of the north of Europe is not different from that of the Mediterranean species). 3, 2000′—4800′; beech region. 4, —6500′; pine region. 5, —8500′; region of the alpine plants. 6, —9036′; region of snow. The vegetation of the Golaz mountains resolves itself into the oak forests (1500′—2000′: *Quercus Robur, pedunculata, Cerris,* and *pubescens*), beech forests (2000′—3410′), alpine pastures, and the rocky formation. In addition to this main subdivision, separate arrangements in groups are also mentioned, e. g. shrubs of *Ornus* in the lower, and of *Corylus Avellana* in the upper part of the oak-region, herbaceous meadows of *Cytisus* and *Genista*, &c.

Wierzbicki has published a Catalogue of the Plants found in the Banat (Ratisbon Flora, 1845, pp. 321-25), subsequent to the appearance of the most recent work on the flora of this province (Rochel's Travels in the Banat, 1838); also, Prof. Fuss, of Hermannstadt, a list of 319 plants of Siebenburg, with their localities (Archiv des Vereins für Siebenbürg. Landeskunde, (Bd. 2, Hft. 3).

O. Heer's memoir upon the Upper Limits of Animal and Vegetable Life in the Swiss Alps (Zürich, 1845, 4to), is more important in a geological than a botanical point of view, on account of the descriptions and illustrations of new insects belonging to the snow-region contained in it; however, it also contains some valuable observations on the forms of plants, which, under certain conditions, vegetate above the snow limit (8500′).

Lichens extend far above the Phanerogamia and Mosses; they exist even on the summit of Mont Blanc. The highest of the Phanerogamia was *Androsace glacialis* (*pennina* Gaud.), and occurred at 10,700′ on Pic Linard; and from this altitude down to 10,000′, the following were found in succession on different glaciers, i. e. on account of the position or inclination of the surfaces free from snow on the Rhetian Alps: *Gentiana bavarica*, var. *imbricata, Silene acaulis, Chrysanthemum alpinum, Ranunculus glacialis, Cerastium latifolium*, var. *glaciale, Saxifraga oppositifolia* and *bryoides, Cher-*

leria and *Poa laxa*. Associated with these between 10,000′ and 9000′ we find 50 more, and as far as 8500′, i. e. at the snow-line, 46 others; so that the entire flora of the Rhetian Alps consists of 106 Phanerogamia, belonging to 23 families. All these plants are perennials, most of them cæspitose, hence they are propagated without the seed arriving at maturity; all of them are depressed and small, and are thus less influenced by the heat of the air than of the soil: in fact, the only two woody plants are dwarf willows, their stems being almost entirely inserted into the earth. Yet the temperature of the soil at these altitudes is probably for a short time only above the freezing point. The author very correctly explains their being enabled to grow, notwithstanding this circumstance, by the short period of their vegetation, as when transplanted into the low country, they become, without exception, spring plants, which, in a few weeks after budding, ripen their fruit, their winter sleep being proportionately prolonged. Moreover, in the low country they all exhibit but little susceptibility to cold, so that even at the period of their flowering, although exposed to frost, they are not at all injured. Even if, in their elevated position, the spring season should not occur, they would endure a state of hybernation for several years, without being destroyed. The conditions of vegetation being so different from those of the level country, explains the fact that the Phanerogamia of the snow-region never become spontaneously distributed in the valleys. The case is different with the Cryptogamia; for the lower the degree of organization, says Heer, the less does the form require to be modified, to adapt it to a different climate.

Mougeot and Nestler have published, in connexion with W. P. Schimper, the twelfth century of their well-known collection of dried Cryptogamia from the Vosges (Stirpes Cryptogamæ Vogeso-Rhenanæ, fasc. 12. Bruyère, 1844, 4to).

French local floras and systematic contributions upon French plants: Observations sur quelques Plantes Lorraines par Godron (Nancy, 1835, 8vo, pp. 31), containing a supplement to his Flora of Lorraine; Choulette, Synopsis de la Flore de Lorraine et d'Alsace, Partie i, Tableau Analytiques (Strasb., 1845, 16mo); Cosson et Germain, Flore descriptive et analytique des Environs de Paris (Paris, 1845, 8vo, 2 vols.), remarkable for its accuracy, and the systematic investigations contained in it; it gives satisfactory elucidations, e. g. of *Astrocarpus Clusii*, *Trifolium Parisiense*, *Euphrasia Jaubertiana*, *Potamogeton tuberculatus*, and *Carex Mairii*; Puol, Catalogue des Plantes

qui croissent dans le Département de Lot (in the Annuaire du Département, pp. 1845, 1846), extending to Hexandria; F. Schultz, Continuation of the communications on the Orobancheæ of France (Ratisbon Flora, 1845, p. 738); Desmazières, Eleventh Contribution to the knowledge of the Cryptogamia of France, containing Fungi (Ann. Sc. nat., 1845, 3, pp. 357-70).

The excellent observations of Ch. Martins on the climate of France, which were mentioned in the preceding Annual Report, are now published in greater detail, and have been augmented by a description of the botanico-geographical relations (Essai sur la Météorologie et la Géographie botanique de la France; separate division of the encyclopædic work, Patria; La France ancienne et moderne. Paris, 8vo).

The French botanical geography, however, is merely based upon the facts given in Duby's 'Botanicon Gallicum.' The distribution of about 3700 Phanerogamous plants through France is shown by a series of lists. 1. 1250 species are diffused over the entire country; i. e. they occur in the local floras of Boreau, Godron, Cosson and Germain, and Dumortier, and in Bentham's 'Catalogue of the Flora of the Pyrenees.' 2. About 30 species, most of which are distributed over Central Europe, correspond, in France, to the climate of the Vosges and Seine. (See the preceding Ann. Rep.) 3. About 30 species belonging to the valley of the Rhine, are confined to the Vosges climate: the mountain plants of the Vosges, which, however, appear also to occur on other mountains of France, are separated from these, as also the southern forms of the valley of the Rhine (10 species), but which according to their distribution ought rather to be arranged in the third list. 4. About 30 species of plants belonging to the north-west, corresponding to the climate of the Seine. 5. The centre of France forms a transition-district from the north to the south, and has only 3 species peculiar to it. 6. 750 species belonging to the south of France, correspond to the climate of the Garonne and Rhone, but they also occur in the Mediterranean district. 7. 800 species are confined to the Mediterranean climate. 8. 500 species belong to the subalpine region of the mountains of France, the level of which, between the 46° and 49° of north latitude, Martins estimates at from 600 m. to 1600 m.; south of 45°, from 1000 m. to 1800 m. 9. 300 species grow beyond these limits in the alpine region. The conclusion consists of plants arranged according to the localities.

In the same paper Martins also publishes the following measurements of the limits of vegetation in Dauphiny:

Cultivation of barley. Upper limit.
Col de la Vachère. North side, 1745 m. South side, 2110 m.
Fagus sylvatica. Upper limit.
Grande Chartreuse, 1465 m. Col des Sept Lacs, 1475 m.
Pinus abies. Upper limit.
Grande Chartreuse, 1631 m. In a shrubby form, 1900 m.
P. picea. Upper limit.
Col des Sept Lacs. North side, 1770 m. South side, 2045 m.
Alnus viridis. Upper limit.
Col des Sept Lacs. North side, 1910 m.
Sorbus aucuparia. Upper limit.
Col de la Vachère. North side, 2000 m.
Rhododendron. Lower limit.
Col des Sept Lacs. North side, 1160 m. Grande Chartreuse, 1660 m.
Col de la Vachère. North side, 2125 m.
Upper limit.
Col de la Vachère, 2410 m.
Pinus Cembra. Lower limit.
Col de la Vachère, 1740 m.
Upper limit.
Col Longet, 2515 m.
P. larix. Upper limit.
Col Longet, 2515 m.

Daum has described two barren, almost desert regions on the south coast of France (Bemerkungen über die Landwirthschaft in Südfrankreich. Charlottenb. 1844, 8vo).

The plain of Crau, which lies to the south of Arles, covers nearly seventy-five square miles; it consists of a gravelly surface, containing scattered, but nutritive herbs and grasses, upon which no kind of agriculture can be carried on, but 30,000 fine sheep find pasture from late in the autumn until the spring, when they are driven upon the pastures of the Maritime Alps; and which it is now being commenced to convert into meadow-land by artificial irrigation; next the plain of Camargue, in the delta of the Rhone, a boggy salt-marsh, nearly half of which consists of flooded land and bog, the remainder of pasture-land and a few fields, and which, by means of a large capital, it is also being attempted to turn to advantage by canal drainage. As regards the agriculture of the province, the traveller remarks that, on account of the grape-vine requiring a large quantity of manure, without affording nutriment to cattle, the principal object is the cultivation of fodder, for as there are no meadows, this is necessarily obtained from lucerne. These facts show the natural character of the country.

Cuynat's Topography of Catalonia (Mémoires de

l'Académie de Dijon, 1845), contains a Catalogue of the Plants found in this Spanish province (2, pp. 91-100).

Six hundred species are enumerated, but most of them are so much more extensively distributed on the Mediterranean coasts, as to prevent our obtaining an accurate idea of the peculiar nature of the vegetation of Catalonia, which has not yet been described.

Willkomm's sketch of Monserrat, with which he concludes his Botanical Reports upon Spain, may be mentioned as a contribution towards filling up this deficiency (Bot. Zeit., 1846).

This isolated conglomerate mountain, which the traveller visited in April, is scarcely more than 3000′ in height; but the summit is only accessible by a deep rocky valley, which runs in a north-westerly direction, whilst the outer sides rise so steeply that they cannot be ascended. In Catalonia, the "warm region," which undoubtedly corresponds to the region of *Chamærops* (see below), extends scarcely more than 1000′; hence the greater part of the Monserrat belongs to "the mountainous region" (the region of evergreen oaks), and the summit reaches the subalpine region (region of the pines). The Mediterranean, as also the Central European plants, are mixed on this mountain with a number of Pyrenean plants. In the lower region, the heights at Bruch are covered with forests of *Pinus halepensis* and *pinea*; the other parts are covered with freely-vegetating "montebaxo," consisting of evergreen oaks, *Pistacia lentiscus, Erica arborea,* and other shrubs. Characteristic plants: *Genista hispanica, Euphorbia oleifolia* G., *Globularia Alypum, Coris monspeliensis,* and *Passerina tinctoria* Pourr. At the central elevation: *Polygala saxatilis* Lag.; *Erodium supracanum, Sarcocapnos enneaphylla, Carduus tenuiflorus* Salzm.; *Ramondia pyrenaica,* and *Convolvulus saxatilis.* The upper region was not developed at that season; however, *Arctostaphylos uva ursi, Globularia nana* Lam., and *Narcissus Jonquilla,* were in flower.

The families containing most species in the flora of Castile form the following series, according to Reuter's collection, which contains 1232 sp. (Boissier, Voy. en Espagne, i, p. 207): Graminaceæ (161 sp.), Leguminosæ (130), Synantheraceæ (125), Cruciferæ (74), Caryophyllaceæ (52), Rosaceæ (38), Ranunculaceæ (33), Boragineæ (31), and Chenopodeaceæ (26).

According to Willkomm (loc. cit.), the Sierra Morena contains an uncommonly uniform vegetation, notwithstanding its great length and breadth. With an average breadth of 8 geogr. miles, it extends from Murcia to Algarve, only forming, however, an intermediate mountain chain, the crest of which, for the most part, only ascends to 2—3000′, and the greatest elevations of which are hardly 5000′. By the density of its forests or tall shadowing

shrubs, and by this connected green and fresh vegetation, the Sierra Morena differs from all other mountains of Andalusia, which only contain isolated spots of wood, and a low, barren "montebaxo." Geologically considered, the principal rocks of the Sierra Morena consist of sandstone, which, in the form of grauwacke, forms the greater part of the mountain-chain, occurring from 4 to 6 geog. miles broad, in gently-rounded mountains and undulating summits, alternating at Almaden with clay slate, in the province of Huelva with gneiss, and southwards, near the low plain of the Guadalquiver, inclosed by other sandstone formations. The central portion of the mountains is interrupted by the immense granitic formation of Cordova, which, in the form of an elevated plain, inclines from Hinojosa towards the north, and becomes connected there with white quartzose rocks, which, between Almaden and Fuencaliente, appear to form the highest chain of the whole Sierra. In the opinion of the traveller, the character of the vegetation is associated with these geological variations, which are lithologically unimportant. The predominating shrub on the grauwacke, as far as Portugal, is *Cistus ladiniferus*, which extends over the Sierra Morena for a length of more than 50 geog. miles, and "frequently covers whole square leagues exclusively." Next to this, the most common are *Phillyrea angustifolia*, *Rosmarinus*, and a *Helianthemum*. The forests on the grauwacke consist of evergreen oaks, of *Quercus Ilex*, *Ballota*, and *Suber*, but the first is mostly only a shrub; the dry, arid, but densely-populated granite plateau is very sterile, but still possesses extensive woods of *Quercus Ilex* and *Ballota*, only a dwarf growth, however, of *Quercus Ilex*, mixed with *Cistus ladaniferus*, *Phillyrea angustifolia*, and *Arbutus unedo*. The southern sandstone chains are furnished with an extremely luxuriant and varied "montebaxo," which, near the city of Cordova, alternates with woods of pines and cork-oaks. The quartzose rocks of Mancha are also covered by a "montebaxo" abounding in forms, among the shrubs of which *Cistus populifolius* is distinguished. Finally, in Huelva, Portuguese forms are associated with the other shrubs, as *Genista tridentata*, *Ulex genistoides*, and with these *Erica umbellata*, *Teucrium fruticans*, and *Helianthemum halimifolium*. Unfortunately, Willkomm has not made us ac-acquainted with the vernal vegetation of the Sierra Morena, which would be the most interesting. But the dryness of the summer commences here in July, and from that time until the autumn no more flowering plants are met with. Different kinds of bulbous plants appear very uniformly distributed in the autumn, as *Scilla maritima*, *Scilla autumnalis*, *Leucojum autumnale*, *Merendera Bulbocodium*, &c.

Boissier's large work upon the southern border of Granada and the Sierra Nevada forms the most valuable contribution to botanical geography which has been made during the past year (Voyage botanique dans le Midi de de l'Espagne, t. i. Narration and Géographie botanique,

pp. 241. Paris, 1845, 4to); as regards the earlier systematic parts of this illustrated work (t. ii), see the Ann. Rep. for 1840-1.

Boissier's excellent account includes the coast-terraces between Gibraltar and Almeria, towards the centre of the country as far as the elevated surfaces of Andalusia, and thus entirely includes the highest mountain-chains of the south of Spain. Along the entire coast-line a series of isolated mountain-chains, consisting of marmoraceous limestone, arise directly, in almost every case, without any intervening land, the western extremity always ascending highest, whilst towards the east the ridge gradually falls: to this system belong the Serrania de Ronda (6000′), Sierra Tejeda (6600′), and Sierra Gador (7000′). These chains, which run parallel with the coast, may be considered as forming the southern mountain-border of the Spanish plateau; for its northern foot, at an elevation of from 2000′ to 2500′, passes directly into the elevated plain of Ronda, the Vega in Granada, or the great plains of Guadix and Baza. In a line from Ducal to Almeria, not far from Granada, the chain of the Sierra Nevada, twenty-two leagues only in length, is inserted between the boundary chain and the elevated plain; it is nearly twice their altitude, but narrow, its highest summits ascending to an elevation of 11,000′. In fact, the passes in the western portion are not situated below 9500′, whilst toward the east the mean height of the crest appears to diminish to 6000′. The Sierra Nevada is mainly composed of mica-slate, but on its flanks secondary and tertiary formations have been carried up with it as far as an altitude of 6000′. The district of Alpujarra forms an important constituent of these mountains; it includes the longitudinal valley running between the coast-chain S. Contraviesa and the Sierra Nevada, together with the southern intersecting valleys of the latter. The following are some of the heights which were measured by Boissier with the barometer: The city of Ronda, on the plateau, 2300′; Granada, 2200′; Sierra Nevada, the farm of San Geronimo, 5064′; Col de Vacares, 9472′; Picacho de Veleta, 10,728′; Mulahacen, 10,980′.

Four botanical districts, which Boissier distinguished in South Granada, yielded him vascular 1900 plants, which he is inclined to regard as forming three fourths of all the indigenous plants of this district. The author considers the following as among the general characters of the flora—viz. that many forms cover the soil in gregarious condition, and that the south of Spain contains more thorny plants than any other country in Europe, and hence resembles the steppes of Western Asia, although the families which develope the thorns are not the same. The hot region (région chaude) comprises the coast declivity up to a level of 2000′. Intense atmospheric precipitations fall during October and November; the vernal rainy season, which is less regular, lasts from February to March, sometimes until April; uninterrupted drought prevails from April to the end of September. Thus the dry season

there, is probably of longer duration than in any other point of the Mediterranean flora. Observations are given, made at Malaga, during nearly three years (1836—1839), by Haenseler, on the distribution of heat; the extreme temperatures of which, as also the monthly average, calculated from the corresponding months of the year in which the observations were made,* yields the following values:

	Med.	Max.	Min.
January . .	12°·25	17°·22	6°·2
February . .	14 ·3	18 ·25	6 ·1
March . . .	15 ·8	21 ·62	10 ·0
April . . .	17 ·8	25 ·0	11 ·25
May . . .	21 ·2	24 ·5	15 ·72
June . . .	23 ·4	26 ·87	20 ·12
July . . .	26 ·2	31 ·87	23 ·5
August . . .	26 ·8	30 ·6	23 ·75
September . .	24 ·4	29 ·87	19 ·37
October . .	22 ·25	25 ·5	19 ·25
November . .	18 ·15	22 ·75	11 ·2
December . .	15 ·75	21 ·0	8 ·5

Mean annual temperature, 17°·3

The vegetation passes through phases corresponding to this climate. After the dry season, Liliaceæ are developed during the first rain of October or November; these are succeeded by the annuals, which flower throughout the entire winter. The flowering season of most of the plants is in April and May; in June and July, when all the annual plants have withered, herbaceous plants belonging to the families of the Synantheracæ, Umbelliferæ, and Labiatæ flower; lastly, from August to September, the most profound repose of vegetable life prevails, so that two or three Liliaceæ, *Mandragora*, and *Atractylis gummifera*, are all that remain. The hot region is principally characterised botanically by *Chamærops*, which covers large tracts and prevents cultivation; as in Valencia, it only ascends to 2000′. Among the cultivated plants, the orange also corresponds accurately to the extent of this region. The soil of other parts is principally devoted to the cultivation of the grape-vine, the fruit of which ripens at the end of August. The Cerealia require artificial irrigation: on those parts which are reached by the water from the mountains, either in its natural descent or by aqueducts, we sometimes find most luxuriant fields of maize and wheat, shaded by orange and mulberry trees. But such oases are rare on these bare and arid slopes, on which wheat is reaped as early as the latter half of June, and barley in May. However, on a narrow coast-district which surrounds the coast-chains,

* The average which I have calculated refers, for June, July, and August, to two, and for the other months to three years.

sometimes in the form of a surface containing salt-water lagunes, at others as a line of hills, and which at Malaga alone is covered with a more extensive alluvial plain, the cultivated plants are confined to the hot zone (0′—600′), as the sugar-cane, the cotton-plant, and sweet potato, the Date-palm and *Ceratonia*, as also the migrated Agaves and Opuntias, with several indigenous plants, as *Aloe perfoliata* and *Withania;* excepting the white poplar, indigenous trees are absent from this littoral district. Boissier enumerates altogether 19 trees as belonging to the hot region, part of which, however, like the Agrumæ, are of foreign origin. The following only can be regarded as indigenous: *Ceratonia*, which ascends 2000′, *Zizyphus*, *Punica*, *Celtis australis*, and *Populus alba*, with those which extend into the following region, where they become more common—viz. *Ficus carica* (0′—3000′, on the southern slope 4000′), *Olea europæa* (vid. supra), *Quercus Ballota* and *lusitanica* (3000′), *Q. Suber* (4000′), *Q. Ilex* (4500′), and *Pinus Pinaster* (vid. supra), The following are the most important formations of the hot regions: *a. Maquis* (Montebaxo). Shrubs from 3′—6′ in height cover the greater part of the sloping soil, consisting of *Chamærops*, several *Cisti*, viz. *C. ladaniferus*, *albidus*, and *Clusii;* *Pistacia lentiscus*, *Rhamnus lycioides*, and *Phillyrea*, numerous *Genistæ*, most commonly *Genista umbellata* and *Retama sphærocarpa*, and some oaks, beneath which numerous annuals and Grasses flower in the winter and spring, and, more rarely, herbs which are developed at a later period. Shrubs of *Nerium* denote the humid soil of the banks of rivers. *b. Campi.* On bare wastes are found predominating *Thymbra capitata*, *Lavandula multifida*, *Teucrium Polium*, and numerous herbs, among which *Centrophyllum arborescens* is pre-eminent. In other places, these are replaced by the social *Macrochloa tenacissima*. In addition to these two principal formations, there are the Halophytes of the littoral district, those plants which are indigenous to the marshes of Malaga, and lastly, the plants of the cultivated part of the country, with its hedges of Agaves and Opuntias. The following plants belong to the endemic forms of the hot region of Granada: *Caltha europæa* (*Celastrus Voy.*), *Genista umbellata* and *gibraltarica*, *Sarothamnus bæticus* and *malacitanus*, *Ulex bæticus*, *Leobordea lupinifolia*, *Ononis Gibraltarica* and *filicaulis*, *Elæoselinum Lagascæ* and *fœtidum*, *Lonicera canescens*, *Withania frutescens*, *Triguera ambrosiaca*, *Lycium intricatum*, *Lafuentea rotundifolia* (according to Willkomm, but it is absent according to Boissier), *Digitalis laciniata*, *Sideritis lasiantha* and *arborescens*, *Salsola Webbii*, *Passerina canescens* and *villosa*, *Osiris quadrifida*, *Euphorbia medicaginea* and *trinervia*, *Quercus Mesto*, *Salix pedicellata*, and *Ephedra altissima*.

The second region (région montagneuse), or the region of the Spanish plateau, is peculiar to Spain, and cannot be compared with the mountain-vegetation of other European countries. By way of introduction to Boissier's description, I shall premise here a remark upon the climatal cause of this

peculiar condition. In Italy, Dalmatia, and in Turkey, we find immediately above the evergreen region, slopes abounding in forests of Central European forms of trees, and other plants indigenous to this side of the Alps: angiospermous trees, which lose their leaves in winter, even at an altitude of 1200′ to 1500′, frequently begin to denote this second Central European region. In Spain, Boissier, with other authors, distinguishes two evergreen regions: a lower one, which in the character of its vegetation appears to agree with the Italian or Dalmatian, and reaches to 1500′ in Catalonia, and to 2000′ in Granada; and an upper one, which, extending from 2000′ to above 5000′, includes the greater part of Spain, and has no analogy with any other throughout the entire south of Europe. It has been shown by Schouw's investigations, that the climatal cause of the evergreen vegetation of the Mediterranean lies in the aridity of the summer, to which the plants of the north of Europe are not subjected. Out of Spain, the latter again meet with conditions necessary for their existence on the mountain-chains of the south of Europe, in the vicinity of the region of clouds, where, even in the summer, the air contains mists formed from its watery vapour, and where the low scale of temperature is the same as in the climate of the north. The elevated plains of Spain are, however, in summer even more arid than the coast-regions; the humid and mild spring, which stimulates all the plants to flower, is there succeeded by a hot and dry summer and a cold winter; the three seasons of the steppes of Russia are distinguished. Although this explains the fact that some plants of the plateau of Spain recur in the Crimea, or on the elevated surfaces of Asia Minor, yet their number is small; for the contrast of the insular and the extreme climate of the interior of the continent exerts such influence here, that the greater part of the plants of Spain are not exposed to the great winter-cold of the eastern elevated surfaces and steppes. Hence the greater part of the flora of the plateau of Spain must consist of endemic plants, because these climatal conditions do not exist elsewhere in Europe. This is still more strikingly perceptible in central Spain (see the Ann. Rep. for 1843) than in Granada, where the plateau-character is less developed on the mountain-slopes, and the vegetation contains fewer forms. But it is clear that more plants of the evergreen coast-region may occur in a climate of this kind than in that of Northern and Central Europe. Returning to the observations of Boissier, he estimates the region which corresponds in Granada to the plateau of Spain as extending from 2000′ to 4500′ on the northern, and to 5000′ on the southern slopes. Within this region, but not far from its lower boundary, the cities of Granada and Ronda are situated, where, in the winter, the thermometer regularly falls 6—8° below 32° F. for a few days. At its upper limit, e. g. in the village of Trevelez, in the Alpujarras, the snow lies on the ground for four months, from December to April. The summer-heat is frequently greater at Granada than on the coast, but the nocturnal cooling is very considerable. The distribution of the atmospheric precipitations is the same as in the lower

region, except that in the summer thunderstorms are common on the Sierra Nevada, and hence the soil rarely dries up so completely as lower down. The agriculture consists principally in the cultivation of wheat and maize, the upper limit to which coincides with the boundary of the region. The wheat is reaped in July, or, in more elevated localities, at the commencement of August. The cultivation of fruit trees extends to the same level as that of wheat; the chesnut, mulberry, and walnut to 5000′; pears and cherries somewhat higher (the latter, in parts, to 6500′). But the most remarkable phenomenon is, that here, quite independently of their horizontal area, the olive and grape-vine extend to nearly the same level (*Olea* on the northern slope to 3000′, on the southern slope to 4200′; *Vitis* to 3500′ and 4200′). The formations of the second region are nearly the same as in Castile: *a.* "Maquis" of the same aspect as in the lower region, but composed of mostly different species. Genisteæ and Cisteæ are more common here; those most so are—*Cistus populifolius*, *Genista hirsuta*, with *Sarothamnus arboreus*, *Ulex provincialis*, *Daphne Gnidium*, *Rosmarinus*, &c. *b.* Thin forests of *Pinus Pinaster* (1200′ to 4000′) and *P. halepensis* (2000′ to 3000′), or of evergreen oaks, as *Quercus Ilex*, *Ballota* and *Suber* (vid. sup.) The underwood here also consists of shrubs of *Cistus*, the density in the growth of which increases in proportion as the intervals between the trees augment. Characteristic forms of the forest-vegetation: *Cistus laurifolius*, *populifolius*, and *salvifolius*, *Lithospermum prostratum*, *Herniaria incana*, *Scabiosa tomentosa*, &c. In the Serrania de Ronda, this thicket is replaced by a mixed kind of forest, consisting of *Abies Pinsapo* B. (3500′ to 6000′), and *Quercus alpestris* B. (3000 to 6000′). In addition to those above mentioned, the following are the only other trees which occur in this region: *Fraxinus excelsior* (3000′ to 5000′), *Ulmus campestris* (2000′ to 4000′), *Populus nigra* (2000′ to 5000′), and *Pinus pinea* (3000′). *c.* "Tomillares." Low shrubs and herbaceous plants belonging to the families of the Labiatæ, Synantheraceæ, and Cistineæ form a dense expanse of vegetation, among which stellate patches of high turf, consisting of *Stipa*, are distinguished. Characteristic forms: *Thymus Mastichina*, *zygis*, and *hirtus*, *Salvia Hispanorum*, *Teucrium capitatum*, *Sideritis hirsuta*, *Helianthemum hirtum*, *Stipa Lagascæ*, *Linum suffruticosum*, *Artemisia Barrelieri* and *campestris*, *Lavandula Spica* and *Stœchas*, *Helichrysum serotinum*, *Santolina rosmarinifolia*. *d.* Meadows of rigid, tall grasses, which are but little touched by cattle, and consist of *Avena filifolia* and *bromoides*, *Festuca granatensis* and *Macrochloa tenacissima*, cover particular slopes. *e.* Vegetation, consisting of Cynaraceæ, on the untilled fields, on the clay. *f.* Gypsum-vegetation with Halophytes (See Reuter's description of Castile, in the Ann. Rep. for 1843), principally distributed over the elevated surfaces of Guadix and Baza. Characteristic plants, mostly glaucous, and part furnished with fleshy leaves: *Peganum*, *Frankenia thymifolia* and *corymbosa*, *Lepidium subulatum*, *Ononis crassifolia*, *Helianthemum squamatum*, *Statice*, *Atriplex*,

Salsola, and *Juncus acutus*. The following are among the endemic forms of the second region of Granada, in addition to those already mentioned, e.g. *Aplectrocapnos bætica*, *Crambe filiformis*, *Hypericum bæticum* and *caprifolium*, *Rhamnus velutinus*, *Ulex bæticus*, *Genista biflora* and *Haenseleri*, *Sarothamnus affinis*, *Ononis speciosa*, *Anthyllis tejedensis*, *Saxifraga gemmulosa*, *Elæoselinum millefolium*, *Lonicera splendida*, *Santolina canescens*, *viscosa*, and *pectinata*, *Centaurea acaulis*, *Clementei*, *prolongi*, and *granatensis*, *Cynara alba*, *Chamæpeuce hispanica*, *Digitalis laciniata*, *Salvia candelabrum*, *Thymus longiflorus*, *Teucrium fragile* and *Haenseleri*, *Salsola Webbii* and *genistoides*, *Euphorbia Clementei* and *leucotricha*, and *Oligomeris glaucescens*.

Third region (Bossier's alpine region), from 4500′ (5000′) to 8000′. The name applied to this region is not fortunately selected, because at the most it could only be compared with that of the subalpine vegetation of the Alps. But considering that, in addition to many endemic plants, at least a large proportion (two fifths) consist of the plants of Central Europe, it would have been more appropriate to have named it after them. But the question of whether the region possesses natural boundaries is of more importance than that regarding the name. On this point it is at once evident, that the tree-limit, which in most mountains so sharply defines the Central European from the alpine region, coincides in the present instance with the latter (6000′ to 7000′) according to Boissier's estimation. Among the trees which vegetate here we have *Pinus sylvestris*, *Taxus*, *Salix caprea*, and *Sorbus Aria;* hence, in fact, forms belonging to the forests of Central Europe. Now if, as in the Sierra Nevada, the forests had diminished to such an extent, or in the course of time had disappeared, so as at the present day not to have any considerable influence upon the natural character of the mountains, still, to allow of comparison with other mountains, it is requisite to determine the regions according to the sphere of distribution of those species which inhabit a large portion of Europe, and thus afford the most certain standard for the climate of any particular region. In the distribution of a mountain into regions, the height at which the vegetation undergoes a decided change is not the only point to be taken into consideration, but also where the climates corresponding to those of other latitudes approximatively occur; a determination which can only be made by the comparison of the vertical distribution of the same plants. There is another decided reason, which renders it essential to form the regions of the Sierra Nevada beyond the tree-limit (part of Boissier's alpine region and his snow-region) into one. Boissier does not give any other decided difference between the two, than that in the snow-region flakes of snow remain during the summer, and that the taller shrubs are absent. That as the altitude increases, the alpine plants themselves alter considerably, is always found to be the case in the upper mountainous regions; hence the latter might be subdivided, without the accuracy and distinctness of the representation being increased. But the region of

Genista aspalathoides evidently corresponds to the *Rhododendra* of the Alps, the dwarf birch and the shrubby willows of the north; formations which are always considered as belonging to the alpine region, or have been separated from it as subalpine. Hence I propose the following regions for Granada, which are comparable with those of other mountainous countries in the south of Europe, and whereby the most remarkable circumstance, that the alpine region has a very wide, and the central European a very narrow altitudinal extent, vanishes when brought into relation with the general fact which I have elsewhere determined, that in Europe the tree-limit does not ascend southward of the Alps.

A. Evergreen region. 0′—5000′ (4500′).

a. Region of *Chamærops*. 0′—2000′. (Boissier's hot region.)

b. Region of the *Cisti*. 2′—5000′ (4500′). (Boissier's mountainous region.)

B. Central European region, or pine-region. 5000′ (4500′) to 6500′. (Part of Boissier's alpine region.)

C. Alpine region. 6500′—11,000′.

a. Region of alpine shrubs. 6500′—8000′. (Part of Alpine region.)

b. Region of alpine shrubs and grasses. 8000′—11′000. (Boissier's snow-region).

But we must now follow Boissier's further description, and hence take in the two regions which are contained in his alpine region. In the upper part of it the snow settles even at the end of September, and the last masses of snow do not melt until the commencement of June (hence corresponding with the alpine region of the Alps), whilst in the lower part, the soil is only covered with snow for four months (hence the climate of the Coniferous region). The distribution of heat corresponds generally to the position of the coasts; the winter is not cold, and the temperature of the summer never exceeds 77° F. The atmospheric precipitations are distributed over the whole year; in spring, and even throughout the summer, mists and thunderstorms keep the soil moist, and this to a greater extent on the northern than on the southern slope, which explains the greater abundance of plants on the north side of the mountains; consequently all the vegetative conditions of that portion of Europe on this side of the Alps are present. Agriculture is carried on there only as in gardens, at the chalets (Hatos): potatoes and barley, the latter usually only as high as 6300′; at a single spot on the southern slope as far as 7600′. There are no fixed dwellings; the land is only used for pasturage, without, however, affording the same nourishment to cattle as other mountains, for connected portions of meadow-turf are rare, and even here shrubs and thorny plants cover the greater portion of the slope.—Formations of the Central European region: *a.* Shrubs of *Sarothamnus scoparius*, *Genista ramosissima*, and *Quercus Toza*, ascending to 6000′; at the chalets, these are replaced by thickets of *Rosa canina* and *Berberis vul-*

garis.—*b.* Thin forests of *Pinus sylvestris* (5000′—6500′), of small extent on the Sierra Nevada, the trees being only from 20′ to 30′ in height; on the Serrania de Ronda, the Pinsapo forest previously mentioned with isolated trees of *Taxus* (5000′—6000′). The Sierra de las Almijarras, south of the city of Granada, is also partly covered with fir trees up to the summit (vid. sup.), hence the present forests appear to be only the remains of the zone of Coniferæ, which once covered the whole of these mountains, and is now destroyed. In the fluviatile valleys of the Sierra Nevada, isolated groups of trees, forming the remains of large forests, among which are the following, part of which only occur as single trees: *Sorbus Aria* (5000′—6500′), *Cotoneaster granatensis* (5000′—6000′), *Adenocarpus decorticans* (4500′—5500′), *Acer opulifolium* (5000′—6000′), *Fraxinus excelsior* (3000′—5000′), *Salix Caprea* (6000′—6500′), and *Lonicera arborea* (6000′—7000′), which are the tallest trees growing there.—*c.* Thorny, low shrubs of a stunted-growth form, an isohypsilous formation with *a*, which is principally found on a calcareous soil: *Erinacea hispanica*, *Genista horrida*, *Astragalus creticus*, *Vella spinosa*, and *Ptilotrichum spinosum*.—This region also contains numerous rock plants, particularly those belonging to the limestone; lastly, boggy springs, with limited meadows, exist in the valleys, and these are the localities where most of the Central European species exist.—Formations which in my opinion should be enumerated as belonging to the alpine region: *a.* Formation of the Piorno (*Genista aspalathoides*). This shrub, which is sometimes locally replaced by *Juniperus nana* and *Sabina*, forms a broad, connected zone of vegetation (—8000′), and is distributed downwards, like the Rhododendrons, over a tract which extends for a considerable distance into the forests (—5500′). *b.* Isolated pastures of rigid Grasses occur on the sloping ground between the Piorno-thickets. They consist of *Avena filifolia*, *Festuca granatensis*, and *duriuscula*, and *Agrostis nevadensis*.—Among the endemic forms of Boissier's third region, in addition to those already mentioned, we have the following, e. g. *Sarcocapnos crassifolia*, *Silene Boryi*, *tejedensis*, and *nevadensis*, *Arenaria pungens* and *armeriastrum*, *Erodium trichomanefolium*, and 3 other species, *Anthyllis tejedensis* and *Ramburei*, *Astragalus nevadensis*, *Prunus Ramburei*, *Saxifraga Haenseleri*, *Reuteriana*, *arundana*, *biternata*, and *spathulata*, *Reutera gracilis* and *procumbens*, *Butinia bunioides*, *Scabiosa pulsatilloides*, *Pyrethrum radicans* and *arundanum*, *Senecio Boissieri* and *elodes*, *Haenselera granatensis*, *Odontites granatensis*, *Thymus granatensis* and *membranaceus*, *Teucrium fragile*, *compactum*, and other species, and *Passerina elliptica* and *nitida*.

Fourth region (region of snow), 8000′—11,000′. Isolated patches of snow never entirely disappear: a connected layer of snow covers the ground for at least eight months. The soil is constantly kept moist, even in the summer, by the melting snow. Chalets are no longer met with, although cattle are driven up to this elevation. The vegetation consists of alpine herbs and grasses. Only four species of low shrubs belong decidedly to this region,

but of these *Ptilotrichum spinosum* and *Salix hastata* are extremely rare; the two others, *Vaccinium uliginosum* and *Reseda complicata* do not raise their woody stem from the ground. The alpine meadows are called "Borreguiles," and they form here a fine sward of *Nardus stricta*, *Agrostis nevadensis*, *Festuca Halleri*, and *duriuscula*: and upon this turf, *Leontodon*, *Ranunculi*, *Gentianæ*, and other alpine plants grow. In other cases, herbaceous plants, growing in the form of tufts, preponderate, and displace the grass-plat; as *Silene rupestris*, *Arenaria tetraquetra*, *Potentilla nevadensis*, *Artemisia granatensis*, and *Plantago nivalis*. The alpine rivulets arise from small lakes, as also from a single spot of glacier-ice, near which, in moist defiles, we meet with taller herbaceous plants, as *Eryngium glaciale*, *Carduus carlinoides*, and *Digitalis purpurea*. Lastly, come the plants of the loose drift, as *Papaver pyrenaicum*, *Ptilotrichum purpureum*, *Viola nevadensis*, &c.; as also of neighbouring rocks, e. g. *Androsace imbricata*, *Draba hispanica*, *Arabis Boryi*, and *Saxifraga mixta*. The following plants are endemic, in addition to those already mentioned: *Ranunculus acetosellifolius* and *demissus*, *Lepidium stylatum*, *Silene Boryi*, *Arenaria pungens*, *Bunium nivale*, *Meum nevadense*, *Erigeron frigidus*, *Leontodon Boryi* and *microcephalus*, *Crepis oporinoides*, *Jasione amethystina*, *Gentiana Boryi*, *Echium flavum*, *Linaria glacialis*, *Holcus cæspitosus*, *Trisetum glaciale*, *Festuca pseudoeskia* and *Clementei*. Boissier gives the following proportions of the flora of Granada, which are valuable in a statistical point of view. The following are the families containing most species in the systematic section of Boissier's work: 239 Synantheraceæ (containing 80 Cynaraceæ, 65 Cichoraceæ, 64 Senecionideæ, 29 Asteroideæ, 1 of the Eupatorineæ), 202 Leguminosæ, 164 Graminaceæ, 105 Cruciferæ, 97 Umbelliferæ, 95 Labiatæ, 90 Caryophyllaceæ (comprising 39 Silenaceæ, 31 Alsinaceæ, and 20 Paronychieæ), 63 Scrophulariaceæ, 38 Cistineæ, 38 Ranunculaceæ, 37 Rubiaceæ, 36 Boraginaceæ, 34 Chenopodiaceæ, 33 Rosaceæ, 33 Liliaceæ, 32 Cyperaceæ, and 30 Orchidaceæ. Statistical sketch of the four regions assumed by Boissier. In the *first* region, 1070 species were observed, of which one sixth only occurred also in the second region, and a few plants only in sunny places in the upper region. Of this total number, 542 species are ⊙, 442 ♃ and 46 ⊙; as far as I am acquainted, this is the only region at present known, in which the number of annuals is as large or larger than that of the perennials. Of the 442 ♃, 19 are trees (vid. sup.), 58 are shrubs less, and 68 more than 3′ in height, the remainder are herbaceous plants. Of the shrubs, 22 are Leguminosæ (14 Genisteæ), 14 Cistineæ, 13 Labiatæ (low under-shrubs), 6 Chenopodiaceæ, 4 Asparageæ (2 Smilax), 4 Amentaceæ, 4 Solaneæ, &c. The region contains 860 Dicotyledons, 200 Monocotyledons, 10 vascular Cryptogamia, distributed through 82 families, of which the following contain most species: Leguminosæ (147), Synantheraceæ (124), Graminaceæ (106), Cruciferæ (47), Umbelliferæ (47), Labiatæ (46), Caryophyllaceæ (46), Chenopodiaceæ (33),

Scrophulariaceæ (26), Cistineæ (21), and Boragineæ (20). Cryptogamic plants are very rare, because the dryness does not suit the Mosses, nor the limestone the Lichens. According to its geographical distribution, the flora of the first region resolves itself into the constituents: *a.* About 200 are endemic to Spain, or consist of species distributed as far as Barbary or Provence; 12 species only are also found in the East. Characteristic families: 12 Cruciferæ (half of which are Brassicaceæ), 20 Leguminosæ (13 of which are Genisteæ), 24 Synantheraceæ (11 consisting of Cynaraceæ), 12 Scrophulariaceæ (8 *Linariæ*), and 13 Labiatæ. *b.* About 770 Mediterranean plants, the distribution of which is more extensive, but confined to the Mediterranean Sea. *c.* 200 Central European plants, most of which are either ruderal or marsh plants. Boissier observed 698 species in the *second region,* of which one seventh ascend into the third region, and some still higher. They consist of 202 ⊙, 465 ♃, and 31 ⊖. To the ♃ belong 21 trees, 43 tall and 68 low shrubs: of the tall shrubs, 11 consist of Leguminosæ (10 Genisteæ), 4 Cistineæ, 4 Caprifoliaceæ, and 4 Rosaceæ; of the undershrubs of the Tomillares, 13 consist of Labiatæ (4 species of *Thymus*), 12 Synantheraceæ (5 species of *Santolina*), 7 Cistineæ, 7 Leguminosæ (Genisteæ and *Astragalus tumidus*), 4 Ericaceæ, 4 Chenopodiaceæ, and 3 Thymeleaceæ. The region contains 597 Dicotyledons, 93 Monocotyledons, and 8 Ferns, distributed through 65 families, the following of which contain most species: Synantheraceæ (97), Leguminosæ (50), Labiatæ (44), Cruciferæ (41), Umbelliferæ (40), Graminaceæ (36), Scrophulariaceæ (27), and Cistineæ (23). Cryptogamic plants are common, tree-lichens commence at 3300′ in the Serrania de Ronda. The second region contains the following components, arranged according to their geographic distribution: *a.* 220 Spanish plants, of which 22 are distributed as far as Provence; 9 species are also found in the East. Characteristic families: 15 Cruciferæ, 15 Leguminosæ (11 Genisteæ), 15 Umbelliferæ, 33 Synantheraceæ (19 Cynaraceæ), 15 Scrophulariaceæ, and 17 Labiatæ. *b.* About 220 Mediterranean plants. Boissier collected 422 species in the *third region:* of these 333 are ♃, 78 ⊙, and 11 ⊖. To the ♃, belong 14 trees, 44 mostly low shrubs: among these 9 Labiatæ (*Thymus* 5 species), 8 Leguminosæ (6 Genisteæ, 2 Astragaleæ), 5 Rosaceæ, and 4 Thymeleaceæ. The region contains 358 Dicotyledons, 54 Monocotyledons, and 10 Ferns, distributed through 52 families, among which the following contain most species: Synantheraceæ (55), Leguminosæ (29), Graminaceæ (29), Cruciferæ (29), Caryophyllaceæ (29), Labiatæ (27), Scrophulariaceæ (24), and Umbelliferæ (20). Arranged according to their geographical distribution, the third region contains: *a.* 182 Spanish plants, of which 101 species appear at present to be confined to Granada. Characteristic families: 12 Cruciferæ, 14 Caryophyllaceæ, 15 Leguminosæ, 21 Synantheraceæ, 12 Scrophulariaceæ, and 16 Labiatæ. *b.* 185 Central European plants. *c.* 55 Mediterranean plants. In the *fourth region,* Boissier

found 117 species, of which one third also occur in the third. Of these, 5 only are $\odot$, 3 $\odot$, and 109 ♃; moreover, 97 Dicotyledons, 16 Monocotyledons, and 4 Ferns, distributed through 34 families, of which the following contain most species: Synantheraceæ (16), Graminaceæ (11), Cruciferæ (11), Caryophyllaceæ (8), Scrophulariaceæ (8), Ranunculaceæ (5), and Gentianaceæ (5). Of Cryptogamic plants, Lichens growing upon rocks are common. Arranged according to geographic distribution, the fourth region contains: *a.* 45 Spanish plants, of which 30 species are at present peculiar to the Sierra Nevada; 13 species are also endemic to the Pyrenees. *b.* 66 alpine plants, part of which also occur in plains of the north of Europe. *c.* 6 species, which the Sierra Nevada contains in common with other mountains of the south of Europe.

Wilkomm's botanical letters on his travels (vid. supra), relate to the whole of Andalusia, and serve both to confirm and complete Boissier's systematically developed description.

The German traveller at once remarked, that the Sierra Nevada was much more bare and poorer in shrubs than the other mountains of Spain. He found, with Boissier, that the northern slope was richer in plants and more humid than the Alpujarras. In the Serrania de Ronda, he saw the forests of Pinsapo, a tree which unites the growth of the pine with the bark and arrangement of the branches of the red fir, but which differs greatly in the thick and short leaves. At a remote period, a great portion of the Serrania was covered with Pinsapo forests, but the trees have gradually been so cut down, that the Pinsapo is only now seen as a tree on elevated spots; it is, however, found as a shrub from 3000′ downwards. The Sierra Tejada, also a dolomitic mountain between Granada and Velez Malaga, was formerly covered by forests of *Taxus*, from the Spanish name of which, Tajo, the mountain derives its name. Now isolated trees only occur there at the source of the Tagus (Fuente del Tejo). The low eastern prolongation of the Sierra Tejada, the above-mentioned Sierra de las Almijarras is still partly wooded, between Motril and Granada, with pine trees and oaks, consisting of *Pinus pinea, halepensis* and *Pinaster, Quercus Ilex* and *lusitanica*. The slope of this mountain-chain, towards the coast, is also the native place of *Catha Europæa*, a shrub, which is found common between Nerja and Motril. The mountains on the eastern portion of Granada appear to agree in their vegetation most with the Sierra Nevada; as does also the barren Sierra de Alfacar (7000′), which separates the fertile Vega of Granada from the waste and arid elevated plain around Guadix: *Lavandula spica*, with some *Cisti*, there forms the covering of the bare slope. The vegetation of the plains of Guadix and Baza is that of a haloid and gypseous soil. On the boundary near Murcia, we next meet with the high limestone mountain of Sagra, at

Huescar (almost 8000′), where there exist large numbers of pines (*Pinus sylvestris*): the vegetation here also appears to resemble that of the Sierra Nevada, inasmuch as *Lonicera arborea*, e. g. is found there. The same applies to the Sierra de Filabres at Almeria (7000′), where Willkomm met with a number of plants endemic to the Sierra Nevada.

The low plain of Andalusia, or the district of the valley of the Guadalquivir, is inferior to the highlands of the south as regards the abundance of plants it contains, but is at the same time more carefully cultivated, especially around Seville. Willkomm found the tracts lying waste between Seville and Huelva, covered with dwarf-palms, also woods of pines and cork; oaks were common. In the autumn, numerous Liliaceous plants generally flowered there, with *Carenoa lutea* B. (*Pancratium humile* Cav.), one of the Amaryllidaceæ. Along the sandy coast, within the lagunes and salt-marshes, which at Huelva e. g., extend inwards to a considerable distance, pine forests extend from the Straits of Gibraltar to the mouth of the Guadiana, the underwood of which, opposite the coast-branches of the Sierra Morena, consists of *Cistus ladaniferus*, *Ulex Boivini*, &c. On the eastern terminal point of this line of coast, on the Sierra of Algesiras, the traveller met with a splendid forest of tall cork-oaks and olive trees, such as does not exist elsewhere in Spain, where *Rhododendron ponticum* is also mentioned as occurring by Boissier.

Willkomm visited Algarve in February 1846. The inhabitants distinguish three regions in it. *a*. The sandy line of coast (Cousta), which scarcely extends two leagues into the country, was originally a desert ravaged by the sea, but by industry has been converted, especially near Tavira, into a paradise-like district of gardens, containing plantations of southern fruits, vineyards, and corn-fields. Between Faro and Albufeira, this cultivated surface is interrupted by an extensive pine forest, containing *Erica umbellata*. Characteristic plants: *Empetrum album*, *Ulex Boivini* and *genistoides*, *Myagrum iberioides*, *Arenaria emarginata*, *Linaria præcox* and *linogrisea*, *Aristolochia bætica* (*glauca* Brot.) and *Scilla odorata* and *pumila*. *b*. The hilly country (Barrocál), extending to 1000′, is very much divided, and consists of various calcareous conglomerates; it is also fertile and well watered; still a considerable extent of the good soil lies waste, and is covered with Montebaxo. The vegetation was still backward; at Loulé, e. g. *Erica australis* and *lusitanica*, *Osyris quadripartita*, and several *Narcissi*, were found. *c*. The mountainous region (Serra), a terminal, undulating prolongation of the Sierra Morena, like the latter consisting of grauwacke and clay-slate, the western portion only, the Sierra de Monchique, being composed of granite and basalt, appeared dark green, yet not susceptible of cultivation. It is a remarkable fact, and tends to show the great influence of the geological substratum, that even here the shrubs of the Spanish Sierra Morena predominate, *Cistus ladaniferus* being very common, but mixed with the two *Ericæ* of the Barrocál. The valleys of the Sierra de Monchique are, however,

wooded with chesnut trees and cork-oaks, with which *Rhododendron ponticum* grows in common. This mountain does not ascend more than 3800′ according to Portuguese measurements, but the upper vegetation is subalpine, and corresponds with the altitudes of 5000′—6000′ of Andalusia, which, however, I should not ascribe, as the author does, so much to the influence of the capacity of the granite for heat, as to the cessation of the influence of the plateau. The depression of the climate below the natural standard is not occasioned by storms, but the adjacent sea and low country cause a normal fall of the temperature in a vertical direction; whence Andalusia and the whole of Spain are abnormal in this respect, and the limits of vegetation extend to a disproportionate height.

Schouw has now published his work upon the Coniferous trees of Italy (see Ann. Rep. for 1844), in greater detail (Ann. Sc. nat. 1845, tom. i, p. 230).

Districts of the distribution of the species: 1. *Pinus sylvestris* L. (including *P. uncinata* D. C.) South slope of the Alps, 6000′—below 1000′ at Tagliamento, an Apennine of Montserrat. 2. *Pinus Pumilio*, Hk. South slope of the Alps, 4000′—7500′. 3. *P. magellensis* Sch. (*P. Pumilio* Ten. and *Mughus* Guss.) appears to hold the same relation to 4 as 2 to 1. The Abruzzi at Majella, 5000′—8300′. 4. *Pinus Laricio* Poir. (*P. sylvestris* and *nigrescens* Ten.) forms the forest of Ætna, 4′—6000′. Calabria and Abruzzi at Majella. *Pinus nigricans* Host. and *P. Pallasiana* are probably the same, as I have also assumed. 5. *Pinus Pinaster* Ait. Apennines. 0′—2800′ on Monte Pisano. 6. *Pinus Pinea* L. Apennines as far as Genoa, with 5. 0′—1500′ in the Western Apennines, 2000′ in the south of Italy. 7. *Pinus halepensis* Lamb. The whole of Italy, as far as the Apennines; 0′—2000′ on the Somma at Spoleto. 8. *P. brutia* Ten. Calabria, on the Aspromonte at Reggio, 2400′—3600′. It does not, however, appear to me sufficiently distinct from *Pinus Laricio*. 9. *Pinus Cembra* L. Alps, 4—6500′. 10. *Abies, excelsa* D. C. (*P. Abies* L.), Alps; 1000′ (Tolmezzo)—7000′ (Stilfser Joch). 11. *Abies pectinata* D. C. (*Pinus Picea* L.) From the Alps to Madonia; 1000′—4500′ in the Alps, 5500′ in the Apennines. 12. *Larix europæa*. Alps; 1500′ (at Piave)—7000′. 13. *Cupressus sempervirens* L. Alps to Sicily, 0′—2500′. 14. *Juniperus communis* L. South to 40°; Alps, 0′—5000′. 15. *Juniperus nana*. W. Alps, 5′—7500′; Apennines. 16. *J. hemisphærica* Prl. Ætna, 5′—7000′; Calabria. 17. *J. Oxycedrus* L. Apennines, from 1000′—3000′. 18. *J. macrocarpa* Sibth. Along both the seas from Pisa to Sicily. 19. *J. Sabina* L., Alps; Apennines. 20. *J. phœnicea* L. Along both the seas from Nice to Sicily. 21. *Taxus baccata* L. Alps; Apennines.

Parlatore has commenced a Flora of Palermo (Flora Palermitana, vol. i. Firenze, 1845, 8vo). The first volume contains only the Grasses (130 species), with very full descriptions.

New species: *Avena Heldreichii*, *Melica nebrodensis*, *Vulpia panormitana* and *attenuata* (*Festuca sicula* Mor.)

Regarding the periods of the vegetation of wheat (*Triticum vulgare hybernum*), we find in Daum's work (l. c. p. 347), the following observations made in the year 1842:

Average period of Sowing.			Time of Harvest.	
Malta	Dec. 1		May 13	164 days
Sicily	Dec. 1	(Palermo)	May 20	171 „
Naples	Nov. 16		June 2	195 „
Rome	Nov. 1		July 2	242 „
Berlin				299 „

Link read some observations upon the vegetation of Dalmatia, before the Geographical Society of Berlin (Monatsberichte, Bd. 2).

Visiani has had individual plants of Greece and Asia Minor drawn, from Parolini's collections (Memorie dell' Instituto Veneto, vol. i, 1843): 6 of the Labiatæ (*Thymus*, *Stachys*), 2 Borragineæ (*Anchusa*, *Lycopsis*), *Dianthus Webbianus* and *Sedum Listoniæ*. The new species which he has there proposed had in part, however, been previously described elsewhere.

II.—ASIA.

Parts 11—18 of the 'Illustrationes plantarum orientalium' of Gr. Jaubert and Spach (see Ann. Rep. for 1843) have appeared (Paris, 1844-45). The following families and genera are described in detail: Polygoneæ, Asarineæ, Chenopodeæ, Leguminosæ, principally Genisteæ (including *G. gracilis*, t. 143 = *G. carinalis*, m.), *Cousinia*.—In Lorent's oriental travels (Wanderungen im Morgenlande. Mannheim, 1845, 8vo), 35 species are described by Hochstetter as new, most of them from Syria and Armenia.—Endlicher and Diesing have described 6 Algæ which were collected by Kotschy in the Persian Gulf (Bot. Zeit. 1845, p. 268).

Mahlmann has elaborated Chanykoff's observations on

the climate of Bokhara (Berliner Monatsber. für Erdkunde, Bd. 2, pp. 132-40).

North winds are always prevalent in Chanat, hence they are in the direction from the steppe to Hindu-Kusch, which explains its freedom from rain and its continental distribution of heat. During eight months the wind was in the opposite direction ten times only. In the city of Bokhara (1116′ above the sea) Chanykoff however found the mean temperature during a severe winter = 30° F., i. e. lower, with the exception of Pekin, than has previously been anywhere observed in the same latitude. The trees bud between the 20th of March and the 10th of April. The vegetation of the steppes between Samarkand and Karschi lasts from the middle of March to the end of April; but the temperature remains high from the middle of March to the end of November, and is excessive in the summer.

Tschihatcheff's work upon his travels in eastern Altai, principally the district of the course of the Jenisi (Voyage dans l'Altai oriental. Paris, 1845, 4to), contains a list of the plants collected by the author in a portion of the district, part of which had not been previously examined; when determined by Turczaninow they were found to agree with those of adjacent countries.

The following were the trees: *Larix sibirica, Abies Pichta, Pinus sylvestris* and *Cembra, Alnus viridis, Betula alba, Salix Pontederana, pentandra,* and *stipularis* Turcz., *Populus alba, tremula,* and *laurifolia,* and *Sorbus aucuparia.*—The following families and genera have been described (Bull. Moscou, 1845), as forming an addition to Turczaninow's Flora of the Baikal Regions (see the preceding Ann. Rep.): 1 *Adona,* 1 *Cornus,* 6 Caprifoliaceæ, 7 Rubiaceæ, 6 Valerianeæ, and 2 species of *Scabiosa.*

G. Reichenbach has described some Orchidaceæ in Göring's collection from Japan (Bot. Zeit. 1845, p. 333).

The following divisions of R. Wight's illustrated work upon the flora of Hindostan (Ann. Rep. for 1840) have appeared according to the advertisement: Vol. ii, part 1 of the Illustrations of Indian botany, with 39 plates (Madras, 1841); of the Icones plantarum Indiæ orientalis, the conclusion of the first volume, consisting of 16 parts and 318 plates; vol. ii, with 318 plates (ib. 1840-42); and vol. iii, parts 1-3, with 409 plates (ib. 1843-46). Wight has also published a Spicilegium Neilgherense, with 50 plates (ib. 1846, 4to), in which particular plants of Nielgherry are figured: the latter appears, however, to

be only an abridgment of his previous work (see Gardner's remarks in the Lond. Journ. of Bot. 1845, p. 565).—As stated in a letter, a memoir by Madden upon the Coniferæ of India is contained in the 'Quarterly Med. and Lit. Journal,' 1845, pp. 34-118, published at Delhi.—Gardner, the Brazilian traveller, who is now superintendent of the garden at Columbo in Ceylon, has reported upon his botanical excursions in Nielgherry (l. c. pp. 393-409 and 551-67); he enumerates the localities of the plants existing there.

De Vriese has commenced publishing an illustrated work upon select plants of the Dutch East Indian possessions (Nouvelles Recherches sur la Flore des Possessions Néerlandaises aux Indes Orientales. Fasc. 1, with 3 plates. Amsterdam, 1845, fol.): it contains a description of some new Styraceæ from Sumatra and Java, a figure of *Casuarina sumatrana*, as also of the new *Pinus Merkusii* from Sumatra.—Hasskarl has continued his remarks upon various points relating to the plants of Java both in the 'Ratisbon Flora' (1845, pp. 225 et seq., containing the Rubiaceæ), as also in V. d. Hoeven's Zeitschrift (Bd. 12, pp. 77 et seq., comprising the Malvaceæ and the allied families).—Montagne is describing the Lichens and Mosses of the Philippine Isles, from Cumming's collections (Lond. Journ. of Bot. 1845, pp. 3-11).

III.—AFRICA.

Fresenius has published Contributions to the Flora of Abyssinia from Rüppell's collections (Mus. Senckenbergian. vol. iii, 1845): containing copious descriptions of those Polygoneæ which have already been made known, and some new Synantheraceæ.

He gives, at the same time, a figure of the Lobeliaceous tree of Abyssinia, Gibarra (*Rhynchopetalum montanum* = Jibera of the preceding Ann. Rep.), and has represented its habit as follows: from 6'-7' in height, stem hollow, a crown of lanceolate leaves and tall bunches of flowers; hence the dimensions of the plants observed by Rüppell in Simen, between 11,000' and 12,000'

were less in those found by Harris in Shoa. (See the preceding Ann. Rep. p. 382.) C. H. Schultz has described some of Rüppell's new Cichoraceæ from Abyssinia (loc. cit. p. 47).

Endlicher and Diesing are describing new Algæ from the Natal Colony (Bot. Zeit., 1845, pp. 288-90).

IV.—AMERICA.

Seller has made some isolated systematic remarks upon a collection of plants from the coasts of Davis's Straits and Baffin's Bay, in the 'Annals of Natural History' (vol. xvi, pp. 166-74).

Forry has compared the results obtained at the meteorological stations of the United States since 1819, and traced the distribution of heat in various points of view (Amer. Journal of Science, 1844, extracted into the Biblioth. de Genève, vol. lvii, pp. 140-50).

The unusual, nay, unparalleled accumulation of fresh water in the Canadian lakes, which, at a mean level of 1000′, include a surface of almost 4000 square geog. miles, procures for the northern states an insular climate for a very considerable distance into the eastern forest-region. Hence the difference between the summer and winter does not become excessive until we arrive just beyond the Mississipi, as also between the lakes and the Atlantic Ocean; in Lower Canada, e. g. the extremes of temperature are somewhat greater than in Michigan on the one hand, and the coast of Nova Scotia on the other. In the southern states, the annual curve resulting from the influence of the two oceans becomes still less arched than in the north, until, in Florida, it gives way to an almost tropical uniformity. The difference between the temperature of the summer and winter amounts there at Key West to only 43°F.; flowers bud there throughout the year without any general winter-sleep. During a space of six years the thermometer never rose, at this station, above 89°·6 F., and never sunk below 44°·6 F. The atmospheric precipitations are unequally distributed in Florida: in the central districts there are 309 fine days in the year, on the coast 250, and at the lakes, in the northern part of the state, only 117; but the air generally abounds in moisture, and the formation of dew is common.

Macnab has continued the Botanical Report of his travels (Ann. Nat. Hist., xv, pp. 65 and 351). Berkeley has published an account of some new Fungi from Ohio (Lond. Journ. of Bot., 1845, pp. 298-313).

Geyer's reports upon the characters of the vegetation of the prairies on this side of and beyond the Rocky Mountains (Lond. Journ. of Bot., 1845, pp. 479-92, and 653-62), in connexion with Frémont's investigations (vid. inf.), are immediately connected with the descriptions given by the Prince of Wied, to which the former are far inferior in regard to their too aphoristic style, but are as superior in systematic botanical knowledge.

The traveller ascended the Platte River from the State of Missouri, through the Osage district, as far as its source in the Rocky Mountains, traversed the mountains and the Colorado of California at about the forty-second parallel, and thus arrived at the Oregon territory. The western and southern limit of the prairies, which, to the south of Arkansas (according to De Mofras' map), are connected with the forests of New Mexico (37°) are not far from the Lower Kanza, in the district of Osages (39° N. lat.) Hence even here the forests of the valleys along the river become more numerous, the prairies abound to a greater extent in flowers, and the period of the summer drought is shortened. The most common species among the deciduous trees of Illinois, which are almost the same as those mentioned by the Prince of Wied (Ann. Rep. for 1842), and which also form the forests of the banks of the river on the Lower Missouri, gradually meet here with their western boundary, and they diminish in height the nearer they approach the sandy valley of the Platte. The herbaceous plants of this fertile prairie, however, become proportionately more numerous, and produce an uninterrupted succession of flowers throughout the spring and entire summer. In April isolated spring plants appear; in May and June the whole of the undulating surface for an immense distance is in flower, the plants consisting, e. g. of *Amorpha canescens*, *Batschia*, *Castilleja*, *Pentstemon*, *Cypripedium candidum*, &c.; taller herbaceous plants follow: *Petalostemon*, *Baptisia*, *Phlox aristata*, *Asclepias tuberosa*, *Lilium canadense*, and *Melanthium virginicum;* and finally, in the latter part of the summer, almost exclusively Synantheraceæ, from tall Heliantheæ down to the dwarf *Aster sericeus*.

The rich soil of the prairies terminates at the river Platte, with the limestone of the Missouri, which favours the vegetation detailed above. The lower terrace follows next; it is 900′-1000′ in height, and further up the stream is connected with the elevated surface of the upper steppe. The stony and sandy crust of the earth is formed of the detritus of granite, which is expanded over horizontally laminated sandstone and bituminous slate. The woods on the islands of the river then consist of *Populus canadensis*, *Ulmus americana* and *fulva*, *Negundo* and *Celtis occidentalis;* on the bank, thickets of *Salix longifolia*, with *Amorpha frutescens*, *Rosa parvifolia*, *Rubus occiden-*

talis, and *Rhus glabrum*, predominate on the open prairie, which in May and June is rendered moist by the atmospheric precipitations: the vegetation, nevertheless, scarcely lasts longer than these short weeks of spring. The following forms may be mentioned as characteristic of the flora of the prairie; they are subdivided according to their localities, although the author has not arranged them in the form of a summary:—Of the Leguminosæ, *Astragalus*, e. g. *A. adsurgens* and *caryocarpus*, *Oxytropis*, *Phaca*, *Petalostemon*, *Psoralea*, *Glycyrrhiza*, and *Schrankia*; Malvaceæ, *Sida coccinea;* Cactaceæ, *Mamillaria simplex* and *Opuntia missurica;* Onagrariæ, *Œnothera* and *Gaura;* Synantheraceæ, principally Heliantheæ, e. g. *Echinacea*, *Rudbeckia*, *Heliopsis;* moreover, *Artemisia*, e. g. *A. caudata*, and *Lygodesmia;* Scrophulariaceæ, *Pentstemon* and *Castilleja;* Hydrophyllaceæ, *Ellisia;* Boragineæ, *Batschia;* Nyctagineæ, *Calymenia;* Liliaceæ, *Yucca;* Graminaceæ, e. g. *Sesleria dactyloides*, *Crypsis*, *Stipa*, *Agrostis*, *Eriocoma*, &c.

The remaining large district is denominated by Geyer the upper saline desert region, the area of which extends far inwards symmetrically, on both sides of the Rocky Mountains, from Missouri to Lower Oregon, a desert elevated surface resting upon sandy rocks, and gradually ascending from 1200′ to more than 4000′; so that the chains of the Rocky Mountains, in spite of their elevated central ridges, cannot by any means be regarded as forming a boundary of vegetation. The boundaries of this immense steppe, which everywhere affords pasture, Geyer considers as formed, in the north, by the Saskatchawan and Lake Winnipeg; in the east (the same as the Prince of Wied), by a line running longitudinally through Ioway, or the former district of the Sioux (Great Sioux river and Moine's river); in the south, by the Upper Arkansas; in the west, by the mouth of the Wallawalla, in the Oregon district (more distinctly by Frémont, the union of the two principal forks of this river, the Lewis river and the Upper Columbia); hence about 38°-54° N. lat. and 77°-101° W. long. from Ferro. With the exception of the pine and snow-clad central chain of the Rocky Mountains, this space contains no forests. The prevailing character of the flora is generally the same as that described by the Prince of Wied, that of the Upper Missouri. Beyond the Rocky Mountains also, as in the district of the source of the River Platte, the steppe is covered with two social shrubby Artemisias (*Art. tridentata* and *cana*). The Pulpy-thorn, *Sarcobatus vermicularis* (*S. Maximiliani* N.), also called the Salt-cedar, is found everywhere on the saline soil as low down as Oregon; it is a shrub, with numerous stems from 3′-8′ in height, with diverging thorny branches and dark-green succulent leaves. Considering the similarity of the climate and soil of the prairies and the Russian steppes, it is an interesting fact, that this genus, which was first recognised as distinct, from the examination of Wied's collections, according to both Lindley and Torrey (*Fremontia* ej., *Batis vermicularis*, Hook.), is a true member of the Chenopodiaceæ (Lond. Journ. of Bot., 1845, pp. 1 and 481), and grows in

common with other Halophytes belonging to the same botanical group. The other most common thickets of the upper steppe consist of *Elæagnus argentea* and *Shepherdia argentea*; then *Amorpha frutescens*, *Rosa parvifolia*, and woody Synantheraceæ, e. g. *Iva* and *Bigelovia*. *Juniperus andina* (*J. repens* of Wied), with *Yucca angustifolia*, appear to be confined to the Missouri country below the mouth of the Yellowstone river. Geyer's further distinctions of several districts of vegetation in the region of the upper terraces has not been carried out sufficiently clearly. The following may be regarded as characteristic forms:—Of the Leguminosæ, *Astragalus*, *Homolobus*, *Psoralea*, *Glycyrrhiza*, *Hosackia*, *Schrankia*, and *Amorpha*; Cruciferæ, *Stanleya pinnatifida*; Loaseæ, *Bartonia ornata*; Onagrariæ, *Œnothera*; Cacteæ, *Opuntia missurica*; Umbelliferæ, *Cymopterus*; Synantheraceæ, in addition to the above-mentioned shrubs, several Chrysopsideæ, Cichoraceæ, *Achillea*; Scrophulariaceæ, the same genera as those of the lower terraces; Chenopodiaceæ, in addition to *Sarcobatus*: *Kochia*, *Salsola*, *Chenopodium*, and *Atriplex*; Liliaceæ, *Calochortus* and *Allium*, *Iris*, *Triglochin maritimum*, *Carex*; Graminaceæ, e. g. *Triticum missuricum*, *Hordeum jubatum*, and *Ceratochloa*.

Geyer's description is rendered geographically more clear by the excellent diary kept by Fremont of his travels, who, being the chief of an expedition of discovery, and furnished with botanical knowledge, explored the whole of the steppes of the North American prairies, down to Lower Oregon and Upper California, in different directions, with the most fortunate results (Narrative of the Exploring Expedition to the Rocky Mountains in 1842, and to Oregon and North California in 1843-44. Washington, 1845. I am only acquainted with it from the English edition, London, 1846-8). On this side of the Rocky Mountains, Frémont followed the same course to the River Platte as Geyer; on the second occasion, he ascended the Kanza and its accessory streams, to the central chain. The country ascends very gradually from the bifurcation of the Kanza (79° W. long.), to the foot of the Rocky Mountains, and on the west side of the mountain the land sinks to the conflux of the Lewis and Oregon, as is evident from the following line of level which was determined barometrically by Frémont, and intersects the entire steppe from east to west. Bifurcation of the Kanza (79° W. long.) = 926′; River Platte (81°) = 2000′; River Platte (83°) = 2700′; Fort Laramie, on the Platte (87°) = 4470′; and almost in the same meridian, Fort Vrains (40° 16′ N. lat.) = 4930′; as also the River Arkansas (38° 15′ N. lat.) = 4880′; Artemisia-steppe, at the eastern foot of the Rocky Mountains (41° 36′ N. lat. and 90° W. long.) = 6820′; south pass through the Rocky Mountains, in a deep depression, which does not possess any mountain character (42° 27′) = 7490′; foot of the Rocky Mountains, at the upper part of the course of the Colorado of California (41° 46′) = 6230′; Fort Hall, on the Lewis (43° N. lat., 95° W. long.) = 4500′; River Lewis (43° 49′ and 99°) 2100′; River Lewis (44° 17′ and 100° W. long.) = 1880′.

The open prairie-steppe beyond the Rocky Mountains is covered generally with shrubs of *Artemisia*, between which, however, cattle everywhere find food in nutritive grasses. *Purshia tridentata*, one of the Spiræaceæ, which frequently accompanies the *Artemisiæ*, is a shrub peculiar to this part. The nutritive plants used there by the Indian hunters in cases of necessity, corresponding to the *Psoralea esculenta* on the Missouri, consist of *Valeriana edulis* (Tobacco-root), *Cirsium virginianum*, a species of *Anethum* (Yampeh), and *Kamassa* (Kamas), Fr. indescr. The bank-forests of the cotton-wood (*Populus*) are not met with until we arrive at the lower regions: they appear to be entirely wanting on the upper terrace. At the bifurcation of the Oregon, where the prairie terminates (101° W. long.), the wooded promontories of the western chain of high mountains commence, which may be compared to the Rocky Mountains in extent, and projecting everywhere above the snow-limit, probably exceed them in height. Being a continuation of the Californian Andes, it is called, in Upper California, Sierra Nevada, in Oregon, the Blue Mountains, and the Cascade-chain, where, on the south side of the united rivers, near Fort Vancouver, it rises into high snow-mountains, as at Mount Hood. At Oregon, the forests of this high mountain-chain (explored between 2700′ and 3800′), which are only interrupted by the most splendid meadow-slopes, consist of birch, but above all of various Coniferous trees remarkable for their enormous dimensions, which are such as are not met with in any other part of the globe. The larches were sometimes 200′ high (p. 182), the firs were of the same height, with stems 7′ in diameter; in the former, the unbranched stem beneath the crown was sometimes 100′ in length. White spruces which gave off branches down to the root appeared nevertheless to measure 180′, perhaps 200′.—The Cascade-chain separates the mild climate of the western coast of the Oregon district from the dry prairies equally as definitely, but in an inverse direction, as the Peruvian Andes do the west desert coast-region from the more humid highlands. This meridional mountain-chain, which intersects the River Columbia about twenty-five or thirty miles from its mouth, receives the mists and rain which are driven over to it from the Pacific Ocean, but which do not penetrate to the clear sky of the steppe. At the rapids of the Columbia, the "Dalles" within the mountain-line, the rainy season is already unknown, which on the coast denotes the winter, and this season is only recognisable there (45° N. lat.) by a slight fall of snow, which scarcely lasts on the ground for two months. The cause of the winter rainy season at the mouth of the Oregon, where west winds predominate, appears to me to depend simply upon the fact, that in the summer the sea, whilst in the winter the continent, is the coldest, so that during the latter period of the year, the humid winds from the sea must quickly lose their moisture in passing over the coast-district. But the steppe lying behind the mountains is a highland; as such it exceeds the coast in warmth and dryness, and cannot, therefore,

readily precipitate the aqueous vapour from the westerly current of air. The same, however, holds good here, from whatever other points of the compass the wind may blow, so that instead of steppes, deserts would be expanded between the Rocky Mountains and the Californian Andes, if this internal country were not also so copiously watered by these mountains, and thereby also subject to local precipitations. The climatal relations of the Oregon-district also perfectly explain the drought of the prairies in the Missouri described by the Prince of Wied.

From Columbia, Frémont went to the eastern foot of the Sierra Nevada, as far as the 39th degree of south latitude, following the boundary-line between the steppe- and the forest-regions. Below the 42d degree, at the south water-boundary of the district of the Oregon-river region, the inland country is elevated into a mountain-chain running from east to west, and not void of forests, and this appears to form a connexion between the Californian Andes (S. Nevada) and the Rocky Mountains.

South of the chain, a desert highland is situated; it is probably for the most part uninhabitable, and, from the nature of its soil and its declivity, it may be compared with the uninhabitable regions of Persia; it ought to be called the Californian salt-desert (Frémont's great interior basin). An Indian guide pointed to it, saying at the same time, "There are the great llanos—no hay agua, no hay zacatá, nada"—i. e. Plains without water, without herbage: "Every animal that enters it must die." Entirely surrounded by mountains which form its borders, bounded to the north by the river-limit of the Oregon, to the south by a similar chain, covered with snow, towards the Colorado, and on both sides by the Sierra Nevada and the Rocky Mountains, it only contains internal streams, which lose themselves in the desert or in salt-water lakes, and is perhaps dry and destitute of springs for the space of many days' journey. As the greater part has not hitherto been explored by any traveller, we are confined, with regard to the altitudes, to the following measurements made by Frémont, which, in fact, only relate to the external margin: on the plateau of the great salt-water lake Utah (41° 30′ N. lat. and 95° W. long.) = 4200′; Lake Pyramid, at the foot of the Sierra Nevada (39° 51′) = 4890′; foot of the Sierra Nevada (38° 50′) = 5020′; on the boundary-mountains, Bear River, on the slope of the Rocky Mountains (42° and 93°) = 6400′; pass from the Bear River to Colorado (41° 39′) = 8230′; pass over the Sierra Nevada to the Bay of St. Francisco (38° 44′) = 9338′.—The salt-desert differs from the prairies of Missouri, as from the *Artemisia*-steppes of Oregon, by its excessive dryness, rocky soil with volcanic heaps, by the more general presence of salt in the soil, and, as a consequence of these conditions, by the absence of the growth of nutritive grasses; nevertheless, from the strength and number of the rivers which enter it from the boundary-mountains, we may conclude as to the existence of oases on its streams. The vegetation consists almost exclusively of

shrubby Chenopodiaceæ, with which in tracts Artemisias are mixed, and along the Sierra Nevada, and to the south of the 41st degree of latitude, *Ephedra occidentalis*, forming an evergreen shrub. The most common of the Chenopodiaceæ found here is also *Sarcobatus vermicularis*; *Obione* is next mentioned, of which *Obione rigida* Torr. and Fr., with another new species, occurred at Utah; *Salicornia* also covered the banks of this lake. The woods of the boundary-mountains to the north of Utah consisted of deciduous trees: *Populus, Salix, Quercus, Cratægus, Alnus,* and *Cerasus*. Below the 39th degree of longitude, the Sierra Nevada was crossed with great difficulties in the depth of the winter, so as to reach the valley of Sacramento. The lowest forest-zone on the desert side of the mountains consisted of a pine, the seeds of which were edible, *Pinus monophylla* Torr., a tree from 12′ to 20′ in height, and with a stem at the most 8″ in diameter, which, with some roots and the salmon found in the waters, form the food of the Indians. Further upwards this pine (nut-pine) was found somewhat larger, its diameter amounting to 15″. But it was not until an altitude of 6000′ had been reached, that Coniferous forests of a taller growth and of a different species were met with, accompanied by a more luxuriant vegetation, in which the first indications of a fairer climate were met with, At 8000′ the trees were almost as gigantic as in Oregon: red pines as high as 140′ and 10′ in diameter (*Pinus Colorado* of the Mexicans) predominating, and with them tall cedars 130′ in height, and two species of fir of an equally tall growth (white spruce and hemlock spruce). Trap-rocks form the fertile soil of these splendid tall forests, to a considerable depth. On the west side of the mountains, below the Coniferous zone, Frémont arrived at a region of evergreen and other oaks, which corresponds with Hinds's representation of the character of the region of St. Francisco: here, after the impressions left by the deserts, the traveller was delighted with the most luxuriant spring flowers in the valleys of the Sacramento and St. Joachim.

On his return, Frémont crossed over the Californian Andes by a much lower pass, below the 36th degree, and travelling parallel with the Colorado, on the southern border of the salt-desert, returned to the Great Salt-lake and the Rocky Mountains. This road, which forms the course taken by the caravans in going from New Mexico to California, was rocky and mountainous (sloping off towards the Colorado from about 5000′ to 2000′): the vegetation was scanty, corresponding to the character of the flora of California. A tall Zygophyllaceous shrub (*Zygoph. californicum* Torr., Fr.), a *Yucca*, and numerous *Cacti* constitute the principal forms of plants over extensive tracts; and from the north towards this part, as far as the woods of the *Yucca*, the *Artemisia tridentata* of the steppes extends: the traveller would not, however, give the preference to the former, since the stiff and unsymmetrical form of the *Yucca* appeared to him the most repugnant formation in nature. Among the shrubs of this region, he mentions *Ephedra occidentalis, Garrya elliptica,*

which forms dense thickets on the banks of the rivers, and *Spirolobium odoratum* Torr., one of the Mimoseæ, 20′ in height. The northern forms distributed thus far were (36° N. lat.): *Pinus monophylla, Purshia tridentata,* and *Populus* and *Salix* on the banks of the rivers.

The snow-line of the Rocky Mountains was estimated on the Snow-Peak (42°—43° N. lat.) at 11,800′ (i. e. 1800′ above the measured point 10,000′), This mountain, the summit of which, 13,570′ high, Frémont ascended, belongs to the accessory chain of the Wind River mountains, but is regarded as the most elevated of the entire system. Above the Coniferous region, the altitudinal limits of which were not determined there, it contains a copious alpine vegetation, which, according to the examples brought forward, are principally characterised by Hudsonian forms, just as those of the Alps are by arctic forms.

Frémont's observations upon the tree-limits of the continent of North America are extremely remarkable; they show that they are much higher than in corresponding latitudes of Europe. Not only in the Californian Andes were the pine forests found to extend above 8000′, but on the east side of the Rocky Mountains, in the district of the so-called Park, in the region of the source of the southern bifurcation of the River Platte and the Arkansas (39° 20′ N. lat.), Frémont found that even at an elevation of 10,430′, "the pine forest continued, and grass was good. We continued our road, occasionally through open pines, with a very gradual ascent; and having ascended perhaps 800 feet, we reached the summit of the dividing ridge, which would thus have an estimated height of 11,200′" (p. 314.) Hence the altitude of the tree-limit of the Rocky Mountains in the latitude of Valencia may be assumed as 11,000′; the most elevated tree-limits of the south of Europe, the isotherms of which are of such very different temperatures, scarcely ascend beyond 7000′. If the influence of the highlands of North America is so great in moderating the vertical diminution of the temperature of the summer, we are justified in anticipating similar phenomena in central Asia. There is especially, one observation which corresponds with this supposition, and it is the only one with which I am acquainted, viz. that relating to the valley of Spiti, in Lesser Thibet, where, according to Jacquemont, at the same altitude, but a more southern latitude (32° N. lat.), dwarf trees alone occur. But it is not only the heat which causes the dense tall forests to ascend to such considerable elevations in North America; the humidity of the air or of the soil must also be taken into account. In the south of Europe, the tree-limit does not ascend in proportion to the increase of heat, since it is frequently situated at a greater altitude on the south side of the Alps than at any more southern point of the continent. In Thibet, where the highlands even ascend to the level of the tree-limit, the limitation of the growth of trees is not caused by cold, but by dryness. Now, it is a circumstance common to both the mountain-chains of North America, that under the latitudes

30

of the south of Europe, they ascend far above the limit of perpetual snow. Here the drying influence of the plateau, which lies far below the forests, is removed by the masses of snow; not so, however, in Thibet, where the country corresponding to the plateau ascends to the snow-line. On the mountains of North America, as on the south side of the Alps, sufficient water is thawed in summer from the large fields of snow to irrigate the elevated forests: thus they are provided with a permanent source of moisture; even when the prairies are without rain for months, they never dry up, whilst upon Pindus and the Apennines the winter snow soon disappears; whilst in Thibet the melted snow upon the elevated surface evaporates again, without fertilizing the soil.

In a botanical appendix to Duflot de Mofras' work upon the western coast of North America (Exploration du Territoire de l'Orégon, &c., 2 vols. 8vo. Paris, 1844), a list of about 300 Californian plants is given. It is, however, derived from old sources, and is disfigured by errors of the press to such an extent as to be rendered almost useless.

In the work itself we find the following statements regarding the course of the seasons in California: 1. In Upper California, e. g. in the latitude of St. Francisco (38° N.), the rainy season, with prevailing south-east winds, lasts from October to March. From April to September north-west winds blow; it then never rains, although fogs are common on the coast; the soil also then loses its verdure (ii, p. 46). On account of the length of the drought, the total amount of the atmospheric precipitations is less than in the south of Europe. 2. The vegetating season of the arid western coast of Lower California, however (30° to 23° N. lat.), occurs with its atmospheric precipitations during the summer (i, p. 239). 3. On the eastern coast of this peninsula, at Cape Lucas, in the Gulf of California (mer vermeille), and on the north-west coast of Mexico we find an inversion of the trade-wind, (inversion d'alizé, i, p. 171), as south-westerly or westerly winds predominate there. In Mazatlan (23° 12′) the rainy season coincides with south-westerly and westerly, and the dry season with north-westerly winds (i, p. 172); the same is the case at St. Lucas, where these latter monsoons prevail from November to May (i, p. 229). Within the gulf, where, although it is beyond the tropic, the monsoons are the same, the amount of rain appears to diminish very considerably. We cannot imagine anything more miserable and neglected than these two coasts, which lie waste from a deficiency of water (i, p. 205).

I find a notice of Plantæ Lindheimerianæ, by Gray, which probably contains an account of Lindheimer's

collection from Texas; but I am unacquainted further with the work.

A. Richard and Galeotti intend publishing a monograph of the Mexican Orchidaceæ, which will include 460 species; of these about a third part are new. They have published preliminary diagnoses of the new species (Ann. Sc. nat., 1845, t. iii, pp. 15-33).—V. Schlechtendal's contribution to the flora of Mexico, for the present year, refers to the Asphodeleæ (Bot. Zeit., 1845).

Purdie (Ann. Rep. for 1843) has continued his botanical reports from Jamaica (Lond. Journ. of Bot., 1845, pp. 14-27).

The Cactaceæ, which are common on the south coast of the island, are absent from the north side. In the former locality, at Bath, he found coast-mountains about 3000′ high, covered with a tall forest of *Podocarpus Purdiena* Hook., one of the largest forest-trees of Jamaica; one of them, which had been cut down, measured more than 100′, 40′ up to the crown, and at the height of a man above the root, it was 3½′ in diameter. *Podocarpus coriacea* occurs above a level of 5000′ or 6000′. The coffee-plantations are situated on the south side of the island, e. g. at the pass from Kingston to Bath, between 3000′ and 6000′. *Coffea* does not thrive at a greater elevation.

Kunze has enumerated and described the new species among the Ferns collected by Moritz in Caracas (Bot. Zeit., 1845, pp. 281-8).—Of Bentham's descriptions of Schomburgk's plants from Guiana, the Polygonaceæ (14 sp.) and Thymeleaceæ (3 sp.) have appeared, as also those of the Acanthaceæ (17 sp.) from Nees v. Esenbeck (Lond. Journ. of Bot., 1845, pp. 622-37). Schomburgk has himself described individual species of his collection (ibid., pp. 12, 375).—Gardner has published the diagnoses of 100 new plants, discovered by himself in Brazil, as a continuation of his former work (ibid., pp. 97-136).—K. Müller has resumed the description of Gardner's Mosses (Bot. Zeit., 1845, pp. 89 et seq.)—The continuation of Naudin's contributions to the flora of Brazil (see the preceding Report) comprises the Melastomaceæ (Ann. Sc. nat., iii, pp. 169-92, and iv, pp. 48-57).—

Jameson has described a botanical excursion made at Chimborazo (Lond. Journ. of Bot., 1845, pp. 378-85).

The aqueous vapours of the winds from the sea are precipitated upon the west side of the western Cordillera of Ecuador, to which Chimborazo belongs. Hence, simultaneously with the rainy season of the coast of Guayaquil, wet weather prevails there from the end of December to the middle of May, whilst on the eastern slope, and on the elevated surface of Riobamba, the weather is fine. This contrast exerts an important influence upon the vegetation; hence the numerous Calceolarias and the Alstrœmerias are confined to the western slope; hence also, in the upper regions, tall-stemmed woody plants are isohypsilous with the shrubs of the central Cordillera. Between 13,000′ and 14,000′ *Polylepis lanuginosa*, one of the Sanguisorbeæ, forms a distinct woody zone, regarding which Jameson remarks, that this tree will grow at a higher level than any other upon the globe. Lower down, on the road from Riobamba to the locality of Guaranda, which is situated on the western side of the Chimborazo chain, there exists a meadow-region of the same extent, until, at 12,000′, woods of *Aristotelia Maqui* and *Columellia sericea* are again met with, in which the underwood consists of shrubby Synantheraceæ, Rosaceæ, Melastomaceæ, and Scrophulariaceæ. The report concludes with a list of the families of plants which were found to occur between 12,000′ and 14,000′. Nearly 250 species observed there by Jameson belong to about 50 families. Those containing most species are: 29 Synantheraceæ, 15 Scrophulariaceæ, 11 Graminaceæ, 11 Rosaceæ, 8 Leguminosæ, 7 Gentianaceæ, 7 Umbelliferæ, and 7 Cruciferæ; 14 Ferns and 13 Mosses; also the following characteristic alpine forms: Ranunculaceæ (5), Caryophyllaceæ (4), Ericaceæ (4), Vaccinieæ (3), Valerianaceæ (4), Orchidaceæ (5), and Cyperaceæ (3). South American forms: Loaseæ (2), Passifloreæ (1), *Escallonia* (1), *Columellia* (1), Solanaceæ (5), and Lobeliaceæ (2). The following tropical forms are also found at this level: Melastomaceæ (4), Homaliaceæ (1), Loranthaceæ (2), and Bromeliaceæ (2).

Bridges has reported upon the first-fruits of his botanical travels in Bolivia (ibid., p. 571).—The first part of the botanical division of a very important work upon Chili, by Cl. Gay, has reached us (Historia Fisica y Politica de Chile, por Cl. Gay. Botanica, tom. i, pp. 1-104. Paris, 1845, 8vo). The diagnoses are in Latin, the descriptions in Spanish. The prodromus, when completed, will contain all the plants of Chili, and a select number will be illustrated by copper-plate engravings; but it also includes garden plants.

The genera treated of in the first part, the indigenous ones, are the following: Ranunculaceæ: *Anemone*, 7; *Hamadryas*, 2; *Barneoudia*, *Ranunculus*, 18; *Psychrophila*, 4; and *Pæonia*. Magnoliaceæ: *Drymis*, 2. Anonaceæ: *Anona*, 1. Lardizabaleæ: *Lardizabala*, 2; and *Boquila*, 1. Berberideæ: *Berberis*, 23. Papaveraceæ: *Argemone*, 3; and *Papaver* and *Fumaria*, 1.

V.—AUSTRALIA AND THE SOUTH-SEA ISLANDS.

J. D. Hooker opposes the opinion that all or most of the South-Sea Islands belong to the same primitive formation (Lond. Journ. of Bot., 1845, p. 642).

The resemblance of their vegetation is rather apparent than real, and is principally evidenced in littoral plants, and in those which with man have migrated beyond their native country towards the East. However, that the original vegetation, with which those naturalized have become associated, is endemic to the larger groups of islands, at least, is shown by a comparison of the flora of the Sandwich and Society Islands, for instance, both of which are subject to the same climatal conditions; one being situated north, and the other south of the equator. Few only of the prominent genera are found in both groups. The Society Islands are the poorest, but tropical in their forms, and less peculiar: here the extensive families of the torrid zone predominate, as the Malvaceæ, Leguminosæ, Apocyneæ, Urticaceæ, Melastomaceæ, and the Myrtaceæ. Of the forms peculiar to the Sandwich Islands, the Synantheraceæ, Lobeliaceæ, Goodenoviaceæ, and Cyrtandraceæ, few or no representatives are found. Other families, as the Grasses, Euphorbiaceæ, Rubiaceæ, &c., which are numerous in both Archipelagos, occur for the most part in isolated species. The same view of the endemic character of the Flora of the Sandwich Islands is adopted by Hinds. (Ann. Nat. Hist. xv, pp. 91-3.) With other Floras and those of the most different kinds, isolated points of resemblance only can be shown. Of 165 species which the traveller collected upon the coast there, half are endemic. In a physiognomical point of view the amount of forests is small in comparison with that of other tropical countries, the trees are not tall and only crowded in moist sheltered valleys. Cinchonaceæ, Guttiferæ, Sapindaceæ, Euphorbiaceæ, are found there, mixed with Tree-Ferns, and a single Palm which was originally endemic.

The work of Strzelecki upon New Holland contains a number of valuable details on the conditions of the vegetation of this continent (Physical Description of New South Wales and Van Diemen's Land. London, 1845, 8vo).

The extra-tropical south-eastern coast is exposed pretty uniformly to

variable winds, which are dependent upon the monsoons of the adjacent oceans, but are not the same in the different latitudes. At Port Jackson and Port Macquarie (32° S. lat.) equatorial winds prevail in the summer and polar currents in the winter; in Port Philip (south-eastern extremity of the continent) equatorial currents in the winter, and polar currents in the summer; in Van Diemen's Land the equatorial winds predominate throughout the whole year (p. 168). The amount of rain is far more considerable on the coast than we should expect: on the average it amounts to 48″ 6 in New South Wales, and to 41″ 3 in Van Diemen's Land (p. 192). The temperature is far more uniform than in corresponding latitudes of the northern hemisphere, as is shown by the following table (p. 229).

	Port Macquarie.	Port Jackson.	Port Philip.	Woolnorth in Van Diemen's Land.
Mean temperature	+20° c.	+19° 2 c.	+16° 3 c.	+14° 1 c.
Mean summer temperature	+23° 9″	+23° 2″	+20° 8″	+16°
Mean winter temperature	+16° 1″	+15° 1″	+11° 9″	+12° 3
Maximum of summer	+31° 3″*	+27° 8″†	+32° 5†	+20° 4‡
„ winter	+ 8° 2*	+ 7° 4	+ 2° 7†	+ 8°‡

The influence of the geological conditions upon the vegetation and the cultivation of the soil is exceedingly variable, according to Strzelecki, as shown by a comparison of New South Wales with Van Diemen's Land. In New South Wales, granite, sandstone, and conglomerate predominate; limestone is confined to but few localities; in Van Diemen's Land, porphyry, greenstone, basalt, and trachyte predominate; limestone is also common (p. 360). In the former, the silica existing in the soil favours the nocturnal diminution of temperature, and would act still more prejudicially if the vegetation, which is more dense, did not frequently give rise to the formation of clouds (p. 219). But the small quantity of soluble constituents in the soil renders it only adapted for indigenous plants, as for pasture-land, but not for agriculture.

The botanical letters from New Holland, by Leichardt (Lond. Journ. of Bot., 1845, pp. 278-291), whose great voyage of discovery through the interior of the continent, which has never been surpassed in its results, was described without a view to publication, excite the most sanguine hope that the botanical characteristics of Australia, taken up by such talent for observation, and described in an equally successful manner, will, at some

* The warmest month is November; the coldest, August.
† The warmest month is November; the coldest, July.
‡ The warmest month is January; the coldest, August.

future time, acquire important elucidations from this traveller.

Systematic contributions to the Flora of Australia: Sonder's diagnoses of 76 new Algæ, belonging to Preiss's collection from the Swan River (Bot. Zeit., 1845, pp. 49-57)—Berkeley's new Fungi (54 sp.), from the same locality, and belonging to Drummond's collection.

J. D. Hooker has written a memoir upon the distribution of the Coniferæ in the southern hemisphere (Lond. Journn. of Bot., 1845, pp. 137-157).

Van Diemen's Land contains ten different Coniferæ, which are endemic to the island. They occur in limited localities, and most of them were discovered by Gunn; they are *Callitris australis* Br. (Oyster-bay pine), a tree from 50′—70′ in height; *C. Gunnii* J. D. Hook. (native cypress), 6′—10′ in height; *Arthrotaxis*, 3 sp.; *Micocachrys tetragona* J. D. Hook., a tree from 15′—20′ high; *Podocarpus alpina* Br., a shrub on Mount Wellington, at an altitude of from 3′—4000′; *Podocarpus Lawrencii* J. D. Hook.; *Phyllocladus asplenifolia* Rich. (celery-topped pine), 50′—60′ high; *Dacrydium Franklinii* J. D. Hook. (Huon-pine), the most beautiful tree of them all, from 60′ to 100′ in height, with a diameter of from 2′—8′, of limited occurrence, but used at the harbour of Macquarie as ship-timber.

Sketch of the distribution of the Coniferæ as yet discovered in the southern hemisphere: 16 species in New Holland (10 *Callitris*, 4 *Podocarpus* and 2 *Araucaria* at Moreton Bay), 10 species in Tasmania (vid. sup.), 13 species in New Zealand and the South Sea Islands (6 species of *Podocarpus*, of which the Kaikatia, *Podocarpus dacrydioides* Rich. is most common at the Bay of Islands, 3 *Dacrydium*, *Thuja Doniana* Hook., *Phyllocladus trichomanoides* Don., *Dammara Australis* = Kauri pine, *Araucaria excelsa* Ait. =Norfolk Island pine, probably confined to this island; 8 species in South America (4 *Podocarpus* in Chili and the Brazils, *Thuja chilensis* Hook.; *andina* Pöpp.; *Thuja tetragona* Hook.= Alerse of Chiloe, *Araucaria brasiliensis*=Brazilian pine, *Araucaria imbricata* = Chili pine, on the Andes, from 37° to 46° S. lat.; *Juniperus uvifera* Don., from Cape Horn, remains doubtful; about 6 species in the South of Africa and the Mauritius (2 *Podocarpus*, 3 *Pachylepis*, including *Pachylepis Commersoni* from the Mauritius, and *Juniperus capensis* Lam., doubtful.

We have now received 15 Parts of J. D. Hooker's illustrated work upon his Antarctic Voyage. (The Botany of the Antarctic Voyage. London, 1845, 4to.)

The character of the vegetation of Lord Auckland's islands is more clearly described than before (Ann. Rep. for 1843). It was previously mentioned that these islands, the volcanic soil of which ascends in the form of gentle

hills to an elevation of 1500′, were uniformly covered with forest-, shrub-, and pasture-land. The forest on the abundant humous soil of the coast consists of *Metrosideros lucida,* mixed with an arborescent *Dracophyllum,* the underwood consisting of *Coprosma,* one of the Rubiaceæ, shrubs of *Veronica* and *Panax.* As in New Zealand, beneath the woody plants, social Ferns are abundant. One of them, *Aspidium venustum,* Hombr. Jacquin., the luxuriant foliage of which spreads out from the summit of a stem from 2′ to 4′ in height, and 6″ in diameter, reminding us, in its growth, of the climate of the Tree-ferns of New Zealand, just as the Dwarf-palm does of a tropical climate. Above the forest region, which is confined to the coast, the bush-land alone is found as far as an elevation of 800′, where it is gradually replaced by treeless pastures of herbaceous plants and grasses. The herbaceous plants display flowers equalling alpine plants in brilliancy of colour, and for the most part are vicarious species of alpine types of plants, as *Gentiana, Veronica, Cardamine,* and *Ranunculus.*

Campbell's Island is girdled with rocks, like St. Helena, and does not therefore contain a connected forest-region. Being covered internally by meadows, it only contains the Ferns found beneath the bushes in the Auckland Islands, in isolated sheltered localities. Of the antarctic forms, a large golden-yellow Liliaceous plant (*Chrysobactron*) is found on the rocky heights, in such luxuriance, that the colour of its flowers is perceived by those sailing by at the distance of a mile from the coast.

Summary of the Flora of the Lord Auckland's Islands and Campbell's Island: 3 Ranunculaceæ (*Ranunculus*), 4 Cruciferæ (*Cardamine*), 4 Caryophyllaceæ (*Stellaria,* 3 *Colobanthus*), 1 *Drosera,* 1 *Geranium,* 3 Rosaceæ (*Sieversia* and 2 *Acæna*), 3 *Epilobium,* 1 *Callitriche,* 1 *Metrosideros,* 1 *Montia,* 1 *Bulliardia*; 3 Umbelliferæ (1 *Pozoa* and 2 *Anistome*), 1 *Panax,* 1 *Aralia;* 7 Rubiaceæ (6 *Coprosma* and *Nertera*); 11 Synantheraceæ (*Triscuron, Ceratella,* 3 *Leptinella, Ozothamnus, Helichrysum,* 2 *Pleurophyllum, Celmisia,* and *Gnaphalium*), 3 Stylidiaceæ (2 *Dracophyllum* and *Forstera*), 1 of the Lobeliaceæ (*Pratia*), 1 of the Epacridaceæ (*Androstoma*), 1 of the Myrsinaceæ (*Suttonia*), 2 *Gentiana,* 2 *Myosotis,* 3 *Veronica,* 2 *Plantago, Rumex,* 1; *Urtica,* 2; 8 Orchidaceæ (2 *Thelimitra,* 2 *Caladenia, Chiloglottis, Acianthus,* and 2 undetermined), 2 Asphodeleæ (*Chrysobactron* and *Astelia*), 5 Junceæ (2 *Juncus,* 2 *Rostkovia,* and *Luzula*), 1 of the Restiaceæ (*Gaimardia*), 6 Cyperaceæ (3 *Carex, Uncinia, Isolepis,* and *Oreobolus*), 14 Graminaceæ (2 *Hierochloë,* 4 *Agrostis, Trisetum, Bromus,* 2 *Festuca,* 3 *Poa,* and *Catabrosa*), 17 Ferns (5 *Hymenophyllum, Aspidium,* 3 *Asplenium, Pteris,* 2 *Lomaria,* 2 *Polypodium, Phymatodes, Grammitis,* and *Schizæa*); 66 Mosses, described in connexion with Wilson; 85 Hepaticæ, described by J. D. Hooker and Taylor; 30 Lichens, by the same; 57 Algæ, by J. D. Hooker and Harvey; and 15 Fungi, by Berkeley. Several of the Cryptogamic species are European, but few only of the Phanerogamia, which have either been introduced, or, forming varieties, their determination appeared doubtful.

The Flora of the Antarctic countries commences with the eleventh part of the work, and includes all latitudes situated between 45° and 64° S. lat.; comprising the following points, which were explored by the traveller, Fuegia, the south-west of Patagonia, the Falkland Islands, Palmer's Land, and Kerguelen's Land. Summary of the families as yet treated of: Ranunculaceæ (*Anemone*, 8 *Ranunculus*, 3 *Hamadryas*, and 3 *Caltha*), 1 of the Magnoliaceæ (*Drimys*), 3 *Berberis*, 11 Cruciferæ (*Arabis*, 2 *Cardamine*, 3 *Draba*, *Pringlea antiscorbutica* = the cabbage of Kerguelen's Land, see Ann. Rep. for 1843, *Thlaspi*, *Senebiera*, 2 *Sisymbrium*), 1 of the Bixaceæ (*Azara*, in South Chili), 4 *Viola*, 1 *Drosera*, 13 Caryophyllaceæ (*Lychnis*, *Sagina*, 4 *Colobanthus*, 4 *Stellaria*, *Arenaria*, 2 *Cerastium*), 4 *Geranium*, 2 *Oxalis*, 2 Celastrineæ in Fuegia (*Maytenus* and *Myginda*), 1 of the Rhamneæ from the same place (*Colletia*), 8 Leguminosæ (2 *Adesmia*, 3 *Vicia*, and 3 *Lathyrus*), 15 Rosaceæ (2 *Geum*, *Rubus*, *Fragaria*, *Potentilla*, and 10 *Acæna*), 2 Onagrariæ (*Fuchsia* in Fuegia, and *Epilobium*), 6 Halorageæ (*Myriophyllum*, *Hippuris*, *Callitriche*, and 3 *Gunnera*), 5 Myrtaceæ (*Metrosideros* in the Chonos Islands, 2 *Myrtus*, and 2 *Eugenia*), 1 *Montia*, 1 *Bulliarda*, 1 *Ribes*, 8 Saxifrageæ (2 *Escallonia*, *Cornidia*, 2 *Saxifraga*, 2 *Chrysosplenium*, and *Donatia*). The Umbelliferæ are not yet completed.

The description of the Antarctic Cryptogamia in the 'London Journal of Botany' (see the preceding Ann. Rep.) has been continued; 38 new Hepaticæ have been published by J. D. Hooker and Taylor (1845, p. 79-97), 76 new Algæ by J. D. Hooker and Harvey (p. 249 to 276, and 293 to 298), who have also enumerated the Algæ of New Zealand, at present 124 species (p. 521 to 551).

The first volume of the botanical text of the illustrated work, founded upon Dumont d'Urville's antarctic voyage, has now appeared; it contains the Cellular Plants, by Montagne. (Voyage au Pole Sud et dans l'Océanie sur les corvettes *Astrolabe* and *Zélée*. Botanique, t. i, Plantes cellulaires. Paris, 1845, 8vo.)

They consist altogether of 138 Algæ, 42 Lichens, 48 Hepaticæ, and 40 Mosses. The preface contains lists of the Cryptogamia found in both hemispheres, between the pole and the 50th parallel (they consist of 9 Algæ, 66 Lichens, 11 Hepaticæ, and 14 Mosses); also a list of those species which occur both in high and tropical latitudes (171 species); and lastly, of cosmopolite species (8 Algæ, 6 Lichens, 5 Hepaticæ, and 10 Jungermanniæ). Montagne's new genera had been previously described in a preliminary work. The copper-plates belonging to the Cryptogamic section, by Hombron and Jacquinot, the text of which has not at present appeared, although exquisitely drawn, have been severely criticised by the younger Hooker (Lond. Journal of Botany, 1845, p. 28).

B.—SYSTEMATIC BOTANY.

In conformity with the character of the earlier systematic literature, the description of new forms still predominates, so that even those most capable of the task are still too much drawn away from the more profound establishment of the System of Plants. But as in this Report the latter direction will principally be kept in view, its brevity will not only be excusable in consequence of a defective knowledge of the literature, of which important papers often reach me too late, but will also be an intentional result of the plan of the work.

In January, 1845, the ninth volume of De Candolle's Prodromus Systematis Naturalis (Paris, 8vo) was published, the tenth followed it in April 1846. The families treated of will be mentioned presently. Of Walper's Repertorium of the diagnoses contained in recent botanical works, (Repertorium Botanices Systematicæ, Lips., 1845-6, 8vo,) the conclusion of the Labiatæ appeared in the last part of the third volume; in the fourth volume, which has not been continued beyond the first fasciculus, the Verbenaceæ, Myoporinaceæ, Selaginaceæ, Globulariaceæ, and Plantaginaceæ, and in the fifth volume, supplements to the Polypetalous families treated of in the first volume, principally consisting of a reprint of Jussieu's Monograph of the Malpighiaceæ; these extracts and reprints are, however, anything but accurate, as is well known.

A new part of Sir W. Hooker's 'Icones Plantarum,' containing 50 plates, has been published. (Part .15, vol. viii, p. 1, Nos. 701-750. London, 1845, 8vo.)

Leguminosæ. Bentham is describing the Mimoseæ, and has given a complete synopsis of the genera and species of this group (Lond. Journal of Botany, 1844-5); during the past year, only *Inga*, with 134 species. He reduces this genus within narrower limits (= *Euinga* Endl.), and remarks that either the Monadelphous Mimoseæ, i. e. one third of all which are known, must be arranged in a single genus, or the formation of the leaves

must be recognised as a generic character. Thus he separates *Inga* from *Picetholobium* (which has doubly pinnate leaves) by the simple pinnation only; but in this manner also obtains habitual characters in the more elongated and pubescent flowers, and in the thicker legumes, which are tumid at the margin. It must undoubtedly be admitted as a correct maxim, that when the higher systematic sections, as the families, are limited by the characters of their vegetative parts, the inferior categories, such as the tribes and genera, may also be made to depend upon them, when a natural subdivision of the group is effected by that means.—*Alexandra*, the new genius of the Sophoreæ, a tree from British Guiana, with colossal flowers, has been described by Rob. Schomburgk (l. c. 1845, p. 12).—The revision of the genus *Genista*, by Spach (Ann. Sc. Nat., iii ser. vol. 2, 3), contains a considerable number of new species; but, like the previous systematic works by this author, it cannot be regarded as conclusive, or as a description of the matter contained in it corresponding with the genius of science, but merely an excessively prolix enumeration of descriptive details. Part of the new species consists of unimportant forms, as evidenced by the description of several belonging to *Genista tinctoria;* the diagnoses, of excessive, totally unnecessary length, do not by any means afford a synopsis of the distinctive characters, but rather defeat their object, and, mingled with the extended yet special and abbreviated descriptions, which do not facilitate the recognition of the species as such, since they combine variable with constant characters,—necessarily render this more difficult. The arrangement of the sections and subgenera is of more importance; they are also unnecessarily increased; but they contain analytical details and new observations, which will be of use for a future monograph. *Dendrosparton* Sp. (iii, p, 152) = *Spartium ætnense* Biv., and *Gonocytisus* Sp. (p. 153) = *Sp. angulatum* L., are separated from *Genista*, and placed in distinct genera.

MYRTACEÆ. J. D. Hooker and Harvey have described *Backhousia*, a new genus from New South Wales (Bot. Mag. 1845, i, 4133).

MELASTOMACEÆ. Naudin separates *Microlicia alsinefolia* D. C. and *variabilis* Mart. from *Microlicia*, on account of the somewhat different structure of their anthers, forming them into the new genus *Uranthera*, and retains *Chætostoma* D. C., the proposed character, however, does not contain any characters distinctive from *Microlicia* (Ann. Sc. Nat. iii, 3, p. 189, 190). He elevates *Arthrostemma* sect. *Monochætum* into a separate genus, under the name of the section (4, p. 48). New genera: *Octomeris* Naud., a shrub belonging to the Andes, to which *Mel. octona* Humb. Bonpl. also belongs (p. 52); *Stephanotrichum* Naud. (p. 54), and *Chiloporus* Naud. (p. 57), both from New Granada.

LYTHRARIEÆ. Planchon (Lond. Journ. of Botany, 1845, p. 474) refers *Henslovia* Wall. (one of the Hensloviaceæ Lindl.) to this order. He ascribes to this genus a *Capsula loculicida, valvis medio septiferis basi et apice*

connexis, and places it near *Abatia* R. P. From the figure given in the 'Flora Peruviana,' he also regards *Alzatea* R. P. (*Celastrinea dubia*) as belonging to the Lythrarieæ, and places *Crypteronia* Bl. (*Rhamnea dub.* Endl.) and *Quilanum* Blanc. (*dub. sedis* Endl.) as doubtful synonymes of *Henslovia*; he is, however, only guided by the descriptions of the plants.

DIOSMEÆ. To this order Planchon refers a diœcious genus of woody plants from the Malay Archipelago, which he describes as *Rabelaisia* n. gen., without, however, being acquainted with the structure of the ovary (l. c. p. 519). At the same time the author proposes some changes in the limitation of the Diosmeæ, with which he considers the Zanthoxylaceæ ought to be united, after having separated *Brucea* and *Ailanthus* from the latter group, as proposed by Bennet, and in conjunction with *Soulamea* (*Cardiophora* Benth. according to the author's dissections), which has hitherto been placed among the anomalous Polygaleæ, combined them with the Simarubaceæ. —Torrey and Frémont have described a new genus *Thamnosma*, from Upper California, nearly related to *Zanthoxylon* (Frém. Exploring Expedit. Americ. edit. from the Bot. Zeit. 1847, p. 141).

OCHNACEÆ. Sir W. Hooker refers *Hostmannia* n. gen. (Hook. ic. t. 709) from Surinam, to this family, notwithstanding its bilocular ovary.

EUPHORBIACEÆ. Planchon has described 2 Australian genera (l. c. p. 471, t. 15, 16): *Stachystemon* Pl., which is nearly related to *Pseudanthus*, and *Bertya* Pl. to *Calyptostigma*.

SAPINDACEÆ. Snake-seed, which has lately been introduced into commerce, consists of the spiral embryos, divested of the testa, of *Ophiocaryon* Schomb., one of the Sapindaceæ, the snake-nut tree of Essequibo, formerly referred by its discoverer, Rob. Schomburgk, to the Anacardiaceæ, but which he has now described more completely, and placed in its proper family (l. c. p. 375-8).

MALVACEÆ. Duchartre has published an important account of his researches upon the development of the flowers of the Malvaceæ (Ann. Sc. Nat. iii, p. 123-50), upon the merit of which Ad. Jussieu has expressed himself at length (Compt. rendus, 1845, Aug. p. 417-26). The outer calyx, at the period of its earliest formation, appears to represent a bracteal system. Duchartre considers that the synsepalous calyx is formed in the same manner as all monophyllous floral envelopes, not by the growing together of originally distinct organs, as Schleiden believes, but the tube of the calyx is first formed, from the upper margin of which five sepals spring up. According to my more recent investigations, which were principally made upon the calyx of the Onagrariæ, this view is essentially in accordance with nature; but the sequence of the phenomena is incorrectly described. The free apices of the organ are first formed, the basilar formative points then unite, in consequence of the lateral growth of each individually, and thus, *after* the formation of the lobes, a connected tube of the calyx springs up from the torus. The

marginal union of floral organs of the same whorl, when occurring, must be considered merely as an exception, in opposition to the universality of this process. Duchartre's most important discovery relates to the position of the stamens, and serves to confirm the supposed affinity of the Malvaceæ to the Rhamnaceæ. After the formation of the calyx, the stamens are developed somewhat before the corolla (as in several families with the stamens opposite), as five rudiments of leaves (mamelons) which alternate with the segments of the calyx. These divide while their formation is yet scarcely completed, at first into two segments (dédoublement collatéral), in the same manner as a divided leaf (their development proceeding more rapidly at the two sides than in the median line, the five primitive eminences become five pairs of minute rounded tubercles). Almost simultaneously with the division of those stamens which are first formed, the petals appear; they are opposite the former, and a considerable distance apart. The polyandrous character is produced by the frequent repetition of the same formation in front of the above ten stamens, united in pairs, that is, on their inner side (parallel deduplication: five new pairs of tubercles are formed in a circle, which is situated more internal and opposite to the first). This multiplication of the stamens is not considered by Duchartre as arising from the formation of new and opposite whorls upon the torus; but he appears to regard them, and certainly with truth, as formed from the expansion of the substance of the primary leaf toward the interior. The Polyandrous character is often increased by a second collateral division of the individual stamens. In fact, in *Malope trifida*, and some other species, Duchartre has even finally observed a third collateral division, both of the anthers and of the stamens, so that here, and perhaps generally, the unilocular anthers ought to be considered as the halves of a truly dimidiated stamen. Five teeth to the tube of the filaments, which alternate with the petals, appear to be universal in the buds, and are considered as forming a second circle of stamens, without any convincing argument being brought forward. Regarding the pistil of the Malvaceæ, Duchartre assumes the existence of five primary forms, the two former of which agree in the circumstance, that at first a pentagonal collar-like protuberance (bourrelet pentagonal) arises from the torus at the circumference of the apex of the axis (mammelon central), the angles of which are opposite the petals (at least this position is mentioned as occurring in *Malope*); either numerous carpels then shoot out from the margin of this protuberance (Malopeæ), or five only from its angles (Hibisceæ). The formation of the carpels is also preceded in the Malveæ and Sideæ by a protuberance, which is not, however, pentagonal, but annular. The number of carpels growing from its margin is undetermined. Lastly, the greatest deviations occur in *Pavonia*, and some allied genera, in which, upon an annular protuberance, the rudiments of ten styles are said to appear first, and subsequently to be fused into five ovaries.

Hypericaceæ. Cosson and Germain (Flore de Paris) admit Spach's genus *Elodea* (*Hypericum elodes*), which differs from *Hypericum* in its parietal placentation, whilst the latter has a central placenta. To me, however, the difference appears merely to consist in the parietal placentæ of *Hypericum* meeting in the axis of the fruit, whilst in *Elodea* this is not the case: whether this is a generic character or not must be decided by a future monograph of the family, Spach's work not being sufficient for this purpose.

Caryophyllaceæ. J. Gay's monograph of *Holosteum* (Ann. Sc. Nat. iii, 4, p. 23-44) is characterised by the author's well-known accuracy; but is impaired by the prolixity which is unfortunately so frequently combined with such accuracy, particularly with endless quotations. The following new genera are proposed by Gay in this memoir: *Rhodalsine* G. (p. 25) = *Arenaria procumbens* V. It appears to differ from all the other Alsineæ, in the stamens being biserial, which is, however, a very relative character only: and *Greniera* (p. 27) = *Alsine Douglasii* Fzl. and *Arenaria tenella* Nutt.; characterised by its seeds, which are compressed discoidally.

Cactaceæ. We are indebted, for a scientific summary of the Cactaceæ, to the Prince Salm-Dyck, who possesses the largest collection in existence on the Continent (about 700 forms), and is also one of those best acquainted with this difficult botanical group (Cacteæ in horto Dyckensi cultæ, additis tribuum generumque characteribus emendatis a principe Jos. de Salm-Dyck Paris, 1845, 8vo). *Pfeiffera* S. (p. 40), is a new genus described in this work.

Cucurbitaceæ. Wight has written in the 'Madras Journal of Science,' and Gardner in the 'Lond. Journ. of Bot.' (1845, p. 401), in favour of Seringe—De Candolle's view, that the middle of the carpels is situated in the axis of the fruit, and that the cells of the fruit are formed by the revolute incurvation of their margins, and have endeavoured to support this paradoxical theory by the course of development of the ovary. According to Gardner, the external wall of the fruit is formed by the tube of the calyx only, with which, in *Coccinia indica*, the dissepiments are merely loosely in contact, without adhering to it. The course of the bundles of vascular tissue also, the principal trunks of which, both in this plant and in *Bryonia*, are situated in the axis, is in favour of Seringe's view; but the principal point in the solution of this question consists in distinguishing the placentæ from true carpels, which has not yet been accomplished. It is still extremely improbable that three leaves should grow out of the point of the axis.—Payer remarks (Ann. Sc. Nat., iii, 3, p. 163) that at the lower joints, where three vascular bundles enter the petiole, the stem of the Cucurbitaceæ is not furnished with tendrils, whilst on the other hand, in the case of the upper leaves, according as one or two tendrils are present, it receives two vascular bundles only, or the central one alone. He thus explains the oblique position of the axillary bud, which is always situated opposite the central vascular bundle, and thus, where as usual a single tendril only ac-

companies the leaf, obtains an oblique position. But he does not thus prove that the tendrils are segments of a leaf or stipules, whilst-if they are regarded as entire leaves, this may be proved by the earlier stage of development, before the formation of any vessels (Wiegm. Archiv., 1846, p. 24).

CRUCIFERÆ. Barnéoud has described the small group of the Schizopetaleæ, to which, in addition to the principal genus (containing 2 species), *Perreymondia*, n. gen. Barn. from Chili (with 4 species) belongs (Ann. Sc. Nat. iii, 3, p. 165-8). The characters are limited to the divided petals and the branched hairs, *Perreymondia* not possessing the divided cotyledons, but an ordinary notorrhizal embryo, and as this is the only difference, it cannot constitute a distinct genus. Trautvetter separates *Matthiola deflexa*, Bg. from the genus *Matthiola*, as *Microstigma*, Tr. (Pl. Ross. imagines T. 25). New genera: *Lyrocarpa*, Hook. Harvey (Lond. Journ. of Bot. 1845, p. 76); it has a panduriform silicule, and was discovered by Coulter in California; *Dithyrea*, Harv. (l. c. p. 77), allied to *Biscutella*, from the same source; *Oxystylis*, Torr. Frém. (Explor. Exp. and l. c. p. 41), well characterised, approaching the Capparidaceæ, also from California; *Pringlea*, Anders. d. Hook. (Antarct. Voy. p. 238, pl. 90-1), the above-mentioned cabbage of Kerguelen's Land.

PAPAVERACEÆ. New genera from California: *Romneya*, Harv. (l. c. p. 73), principally distinguished from *Papaver* by the trimerism of the two outer whorls; *Arctomecon*, Torr. Frém. (l. c. p. 40), only differing from *Papaver*, according to the description, in the strophiolate seeds.

RANUNCULACEÆ. For a notice of Barnéoud's work, the whole of which has not yet been published (Compt. rend. 1845, ii. p. 352-4), see Link's 'Physiological Report' (p. 95). Cl. Gay has established two genera from Chili: *Psychrophila* (Hist. de Chile Bot. i. p. 47, t. 2), separated from *Caltha* and *Barneoudia* (ib. p. 29, t. 1, f. 2), allied to *Helleborus*.

SAXIFRAGACEÆ. Gardner describes a shrub which he discovered on the Organ mountains at Rio, as *Raleighia* (Lond. Journ. of Bot. 1845, p. 97), with the following essential characters: Calyx four-partite, valvular, corolla absent, stamens numerous and perigynous, ovary one-celled, with a single style and 3 (— 2) placentæ, supporting numerous ovules, which are subsequently situated on the median line of the valves of the capsule; seeds with an axile embryo; leaves opposite, connate at the base, and serrated. The author refers it to the Bixaceæ, but Bentham rightly places it in the Cunoniaceæ near *Belangera*, as it forms a transition link from this to the parietal families, by its truly parietal placentæ, but differs from the latter by their attachment. Planchon takes a different view of *Raleighia* (ib. p. 476); from the examination of dried specimens, he regards this genus as scarcely generally distinct from *Abatia* (Lythrareæ, vid. Sup.), which cannot be the case unless both Gardner and Bentham have described the fruit and seeds totally incorrectly.

UMBELLIFERÆ. New genus from Lord Auckland's Archipelago: *Anisotome* J. D. Hook. (Antarct. Voy. p. 76, t. 8-10). The Umbelliferæ, Crassulaceæ, &c. proposed in the 'Phytographia Canariensis,' will be passed over until the work is completed.

EPACRIDACEÆ. New genus: *Androstoma* J. D. Hook., from the Auckland Islands (Antarct. Voy. p. 44, t. 30).

MYRSINACEÆ. New genus: *Labisia*, Lindl. (Bot. Reg. 1845, t. 48), from Penang, differing in the induplicate æstivation of the corolla.

BIGNONIACEÆ. In the Prodromus, this family is treated of by De Candolle, jun., in conjunction with the Sesameæ (vol. ix), in accordance with the description prepared by De Candolle, sen. The Sesameæ, which in this work also include the Pedalineæ, appear only to be separated from the Bignoniaceæ, because the type of the fruit is assumed to be quinary. The African species are separated from *Sesamum*, as *Sesamopteris*. The following genera are distinguished from Bignonia: *Pachyptera*, *Macfadyena*, =*B. uncinata* Mey., *Anemopægma* Mart., *Distictis* Mart., *Pithecotenium* Mart., *Cybistax* Mart., *Adenocalymna* Mart., *Sparratosperma* Mart., *Heterophragma* = *B. quadrilocularis* Roxb., *Craterocoma* Mart. The Crescentieæ, which are arranged by Endlicher among the Gesneriaceæ, form, in this work, the second tribe of the Bignoniaceæ, being characterised by the indehiscent fruit and the wingless seeds, found principally in Madagascar: *Tanæcium pinnatum* W. is separated from *Tanæcium*, as *Kigelia*. *Parmentiera* is a new genus from Mexico. The position of *Bravaisa*= *Bignonia bibracteata* Bert. remains doubtful.

GESNERIACEÆ. The Gesneriaceæ having appeared earlier in the Prodromus, the Cyrtandraceæ form an independent family in the ninth volume, the elder De Candolle having left them prepared. *Ramondia* and *Haberlea*, with *Conandron* from Japan, are correctly brought into this family as a distinct group, on account of the septicidal dehiscence of the capsule.

ACANTHACEÆ. New genera: *Lankesteria* Lindl., from Sierra Leone (Bot. reg. Miscell., 1845, p. 86?; *Whitfieldia* Hooker, from the same source (Bot. Mag., p. 4155); *Salpixanthia* Hook., from Jamaica (ibid., p. 4158).

SCROPHULARIACEÆ. Bentham's Monograph fills the greater part of the tenth volume of the Prodromus. With the exception of the Salpiglossideæ, which, notwithstanding the stamens being anisomerous, would have been more properly excluded, and placed among the Solanaceæ, all the genera possess an imbricate æstivation of the corolla. The position of the fourth and fifth petals, which form the upper lip in those furnished with labiate flowers, separates the two principal tribes, being external during æstivation in the Antirrhineæ, whilst in the Rhinantheæ they are included. New genera. Salpiglossideæ: *Leptoglossis*, from Peru. Antirrhineæ: from the west of North America, *Chioniphila* and *Eunanus* = *Mimulus nanus* Hook. and others; from Chili, *Melosperma*. Rhinantheæ: *Tricholoma* (near *Limosella*), from

New Zealand; *Camptoloma*, from the south of Africa; *Bryodes*, from the Mauritius; *Synthyris* (to which *Wulfenia reniformis*, Benth. belongs), from the west of North America; *Radamæa* and *Raphispermum*, from Madagascar; *Micrargeria*, from the East Indies; *Synnema* = *Pedicularis avana* Wall., from Ava. *Otophylla*, *Silvia*, and *Graderia* are separated from *Gerardia*. As regards the special style of Bentham's Monograph, it is characterised by the excellence of the natural division of the genera, and the appropriate contraction of the forms; the new species are very numerous. Webb has published some remarks upon the affinity of the genus *Campylanthus* Rth., from the Canary Isles (Ann. Sc. nat. 3, iii, p. 33), the position of which Bentham had left doubtful. It differs from the Veroniceæ in the character of the stamens; in the latter two posterior, and in *Campylanthus* two anterior stamens are developed, as is also the case in *Anticharis* and *Achetaria*. Webb places them in a distinct group, in which we are more inclined to agree with him than when he wishes to place it near to the Salpiglossideæ and Solanaceæ, from which it differs in the æstivation.

Solanaceæ. *Cyphomandra* Mart. *Solani sp.* R. P., described in a monograph by Sendtner, differs from *Solanum* in its large connective (Ratisbon Flora, 1845, pp. 161-76). New genera: *Jochroma* Benth. = *Habrothamnus* Lindl. ol. (Bot. reg., 1845, tab. xx.), from Ecuador; *Salpichroa* and *Hebecladus* Miers = *Atropæ sp.* Amer. austr. (Lond. Journ. of Bot., 1845, p. 321); *Lycioplesium* and *Chænestes* Mrs. = *Lycii sp.* Amer. austr. (ib. pp. 330-36); *Dorystigma* Mrs. = *Jaborosæ sp. Chilensis*, Hook. ol. (ib. p. 347); *Trechonætes* Mrs. (ib. p. 350), from Chili; *Pionandra* Mrs. = *Witheringiæ sp.* Mart., &c. (ib. p. 353).

Nolaneæ. In 1844, Lindley, in the 'Botanical Register,' divided *Nolana* into five natural genera, and characterised the species belonging to them. Miers has recently also studied the characters of this small group (l. c. pp. 365-469), and described a new type from Chili, *Alibrexia* (p. 505). Miers regards it as a connecting link between Boraginaceæ and the Convolvulaceæ: from the former it differs principally in its habit, and in the position of the embryo; from the latter in its distinct ovaries. *Grabowskya* (one of the Boraginaceæ according to Endlicher, of the Solanaceæ according to others) forms the transition to the former, the Dichondreæ to the latter. If it is desired to preserve a limit between the Boraginaceæ and the Convolvulaceæ, the Nolaneæ must either be regarded as a distinct family, and the Dichondreæ placed with them; or, keeping in view the inflorescence and the æstivation of the Boraginaceæ, both groups must be united with the Convolvulaceæ. However, Miers retains *Grabowskya* as a distinct tribe among the Nolanaceæ, and leaves the Dichondreæ with the Convolvulaceæ.

Erycibeæ. Both the elder and the younger De Candolle, in the Prodomus (vol. ix), have separated *Erycibe* also, another connecting link between

the Convolvulaceæ and the Boraginaceæ, as a distinct family, principally in consequence of the absence of the style, and the one-celled ovary.

HYDROLEACEÆ. They have been worked out in the Prodromus (vol. x) by Choisy. A. De Candolle remarks that in *Hydrolea* the dehiscence of the capsule is marginicidal, whilst in the other genera it is loculicidal; and he thinks that in the latter the ovary ought to be regarded as unilocular with placentæ projecting toward the axis, whence he prefers uniting them with the Hydrophyllaceæ. Choisy takes the opposite view, without, however, enfeebling this argument.

HYDROPHYLLACEÆ. They are treated of by A. De Candolle in the Prodromus (vol. ix), who separates *Eutoca* into two types—*Microgenetes* from Chili, and *Miltitzia* from California.

POLEMONIACEÆ. Also described by Bentham in the above work.

CONVOLVULACEÆ. Choisy's description in the Prodromus (ibid.) is inferior to the other parts of the work in a critical point of view. The new genera admitted are *Marcellia* Mart. from Brazil, and *Seddera* Hochst., Steud., from Abyssinia. Pfeiffer (Bot. Zeit. 1845, p. 673) separates *Cuscuta epilinum* from the genus *Cuscuta* as *Epilinella*, as this species possesses a pentasepalous calyx; also those species which are furnished with capitate stigmata, as *Engelmannia*, a name which will be at once given up.

BORAGINACEÆ. A. De Candolle has described them excellently well in the Prodromus (vol. ix, x), from the preparatory writings of his father, and divides them into four tribes: Cordieæ, Ehretieæ, Heliotropeæ, and Borragineæ. New types: *Gynaion* (a monstrosity of Cordia?), from the Himalaya; *Meratia*, allied to *Myosotis*, from Caracas. *Heliophytum* and *Pentacarya* are separated from *Heliotropium*; *Maharanga*, with a basilar corona, from the Himalaya, from *Onosmodium*; *Pentalophus*, from *Lithospermum*, from the prairies; *Gruvelia*, from Chili, from *Cynoglossum*; from *Echinospermum*, *Heterocarium*, several species from the steppes of Asia. Moris separates *Buglossites* = *B. laxiflora*, D. C. from *Borago* (Turin Cat. of Seeds, f. 1845).

AVICENNEÆ. Griffith read before the Linnæan Society the history of the development of the ovum of *Avicennia* (Proceedings of Linn. Soc., Nov. 1844, in the Ann. of Nat. Hist., xv, p. 197). *Avicennia* has a free central placenta, with suspended ovules, which do not appear to possess any integuments, and were considered by St. Hilaire as funiculi. The embryo of the fertile ovule, after impregnation, grows in the axis of the nucleus on both sides, passes out from its anterior surface, and there attains its principal development, and which does not appear to be accompanied by the deposition of albumen until it reaches the exterior of the original ovule. At a subsequent period, a furrow is formed upon the anterior surface of the albumen, and which corresponds to the points of the cotyledons of the embryo, whilst the embryo-sac passes back into the placenta, and ramifies within it. Finally

the embryo itself passes through the groove mentioned above, so that in the ripe seeds the radicle is the only part inclosed by the albumen, whilst the cotyledons project, free, from it.

GENTIANACEÆ. I have described them in the 'Prodromus' (vol. ix). New types: *Gyrandra*, from Mexico, and *Pagæa*, from South America. I have separated *Lapithea* from *Sabbatia*, *Exochænium* from *Sebæa*, *Pladera* from *Canscora*, and *Petalostylis* from *Leianthus*.

LOGANIACEÆ. According to the limits of this group given in the 'Prodromus (vol. ix), in which it was described by P. De Candolle, and revised by his son, it contains the aberrant forms of several allied families; i. e. in addition to the types admitted by Endlicher, the Spigeliaceæ, with *Mitrasacme*, *Mitreola*; and *Polypremum*; moreover *Lachnopylis* Hochst., and *Gelsemium* Juss.

JASMINACEÆ. According to Wight and Gardner's investigations (Calcutta Journ. of Nat. Hist., and Lond. Journ. of Bot. 1845, p. 398), the genus *Azima* Lam. (*Monetia* L'Hér.), which has been doubtfully referred to *Ilex*, is intermediate between this family and the Oleaceæ. It differs from the Oleaceæ principally in having four stamens, erect ovules, and the absence of albumen; from the Jasminaceæ in its distinct petals and diæcious stamens, i. e. in characters which occur individually among the Oleaceæ. In habit it resembles the climbing Jasminaceæ.

CAPRIFOLIACEÆ. C. A. Meyer has produced a monograph of those species of *Cornus* in which the involucrum is absent (Mém. de St. Pétersb. 1845, reprinted in the Ann. Sc. nat. iii, 4, pp. 58-74). It comprises thirteen species, four of which are new.

SYNANTHERACEÆ. New genera: Antarctic, by J. D. Hooker—*Trineuron*, *Ceratella*, and *Pleurophyllum*, from the Auckland Islands (Antarct. Voy. pt. ii); *Brachyactis* Led. (Fl. Ross. ii, p. 495) = *Conyza Altaica*, D. C.; *Leucopodum* Gardn. (Lond. Journ. of Bot. 1845, p. 124), a *Conyza* with opposite leaves, from Brazil; *Nicolletia* Gray (Frém. Explor. Exped., and l. c., p. 55), one of the Tagetineæ from California; *Ceradia* Lindl. (Bot. Reg. Misc. 1845, p. 11), a succulent member of the Erechthiteæ, from the West of Africa; *Fitchia* J. D. Hook. (Lond. Jour. of Bot. 1845, p. 640), a Cichoraceous tree; *Harpochæna* Bung. (Delect. sem. Dorpat. 1845) = *Acanthocephalus* Kar. Kir., transferred to the Hyoserideæ; *Heterachæna* Fres. (Mus. Senckenb. iii, p. 74), one of the Cichoraceæ, from Abyssinia. Spach has treated of *Microlonchus* monographically (Ann. Sc. nat. iii, 4, pp. 161-9); eight species are distinguished, part of them from Algeria.

PLANTAGINACEÆ. Barnéoud's Monograph (Monographie générale de la Famille des Plantaginées; Paris, 1845, iv, p. 52) is merely an exposition of the species (114 sp., of which 14 are new), with short diagnoses, composed from the abundant materials existing in the museums of Paris and Geneva. Barnéoud has discovered that, in *Littorella*, before impregnation, the ovary is two-celled, and that one of the two ovules which arise from the

base of the thin septum soon disappears. The author has passed over the character of *Plantago* existing in the structure of the anthers. De Candolle's *Bougueria*, from Bolivia, is figured by Hooker (Lond. Journ. of Bot. 1845, t. 19).

ARISTOLOCHIACEÆ. Griffith establishes a new genus, *Asiphonia*, from Malacca (Linn. Trans. xix, p. 333), and has fully described *Thottea* Rottb. (ib. p. 325.)

RAFFLESIACEÆ. An important memoir upon this group from Griffith was read before the Linnæan Society (Linn. Trans. xix, pp. 303-47, t. 34-9), shortly after that by R. Brown (see Link's Physiological Rep.) Griffith considers the Rhizantheæ as an artificially-formed class, and regards it as a retrograde step in systematic botany. The embryo which he calls homogeneous, does not differ from that of other parasites, e. g. Orchidaceæ, Orobancheæ, &c. as R. Brown has already pointed out; but the ovules of *Balanophora* and *Sarcophyte* consist of simple sacs, without any integument or definable punctum, probably analogous to the naked nucleus of the Loranthaceæ; they cannot therefore remain united with the Rafflesiaceæ, the organization of the ovule of which is perfect. A new genus of Rafflesiaceæ, *Sapria*, from the Himalaya, is fully described by Griffith. Investigations of the Cytineæ follow. Griffith considers the stamens of *Hydnora*, with Meyer, as indefinite, and united into a tripartite column. He also considers the anthers of *Cytinus* (*C. dioicus* Juss.) as probably unilocular. He does not regard the terminal teeth of the column as rudimentary stigmata, but as productions of the connective. He compares the structure of the pistil of *Hydnora* to that of *Papaver* and *Nymphæa*; the organic connexion of the stigma with the placentæ is such, that it might give rise to a new objection to Schleiden's axile placentation (*stigma discoideum, trilobum, e lamellis plurimis in placentas totidem pendulas undique ovuliferas productis*). Griffith's views agree in the most important points with those of R. Brown. The latter retains his former notion, that *Rafflesia* forms a link to the Cytineæ, which, as Griffith appears to admit, are intimately allied to the Asarineæ, but that the latter have no affinity with the Balanophoreæ. Brown's memoir (Linn. Trans. xix, pp. 221-39, pl. 22-30) consisting of the paper which was read as early as 1834, and then published in the form of an extract, is now given complete, and a supplement (ib. pp. 240-9) with a systematic summary of the Rafflesiaceæ added. They are subdivided into the following tribes: Rafflesieæ (*Rafflesia, Sapria,* and *Brugmansia*); Hydnoreæ (*Hydnora*); Cytineæ (*Cytinus*); Apodantheæ (*Apodanthes* and *Pilostyles*). The character of the family runs thus: *Perianthium monophyllum, regulare; corolla O* (*in Apodantheis 4 petala*); *stamina: antheræ numerosæ, simplici serie; ovarium: placentis pluribus polyspermis, ovulis orthotropis v. in quibusdam recurvatione apicis, penitus v. partim, liberi funiculi quasi anatropis* (thus *lycotropis m.*); *pericarpium indehiscens, polyspermum; embryo indivisus, cum v. absque albumine; parasiticæ radicibus* (*v. Apodantheæ ramis*) *Dicotyledonearum.* The ovary of *Rafflesia*, when in flower, is almost wholly free from the perigone, and

wholly so when in fruit. The structure of the pistil remains a morphological puzzle; its numerous irregular cavities, the walls of which are covered with ovules, if the processes terminating the disc be regarded as styles, would lead to the supposition that the ovary is composed of separate (but cohering) simple pistils, arranged concentrically in several rows around an imaginary axis. But this supposition is contradicted by the new *Rafflesia Cummingii* from Manilla, where the number of the ovaries is considerably larger than these processes of the disc. Nor is this difficulty cleared up by the placentæ of *Hydnora*, the structure of which is described in the same manner by both Griffith and Brown (the placentæ may be said to be continuations of the subdivisions of the stigmata). The ovary of *Hydnora* may be regarded as composed of three confluent pistils, having placentæ really parietal, but only produced at the top of the cavity. The testa of the seeds of *Rafflesia* is hard, and corresponds to the simple integument of the ovule; the embryo is inclosed in a loose cellular tissue (albumen) as a cylindrical body (*embryo indivisus*). In *Hydnora*, the spherical embryo is inclosed in a cartilaginous albumen; in the testa of the minute seeds of *Cytinus* a homogeneous nucleus only can be detected, as in the Orchidaceæ.

Balanophoreæ. R. Brown (ibid.) does not at present speak positively regarding their affinity, but makes the following remarks upon their union with the Rafflesiaceæ into the class of Rhizantheæ: 1. That an embryo exactly similar to that of these parasites exists in the Orchidaceæ and Orobanchaceæ. 2. That the anatomical structure of tissue (paucity of vessels, and their limitation to the form of spiral vessels) cannot serve as a character of the Rhizantheæ: *a*, because the Coniferæ so nearly agree in structure with the Winteraceæ; *b*, on account of the peculiarity of the woody tissue of several tropical climbers, which do not recur in allied genera; *c*, because in many families great deviations of anatomical structure are limited to individual forms of plants, as in the Loranthaceæ, e. g. in which the woody tissue of *Myzodendron* Bks. (instead of *Misodendron* Auct.) consists entirely of scalariform vessels. According to Griffith (l. c.) the Balanophoreæ consist of the following genera: *Balanophora* (to which five new Indian species are added), *Langsdorffia*, *Phæocordylis* Gr. (*Sarcocordylis* Walt.?), *Helosis*, and *Scybalium*. As regards their systematic position, Griffith considers them as probably forms of Urticaceæ with homogeneous embryos; but on the other hand he remarks, that their pistil resembles that of the Mosses and Hepaticæ, and that the style is closed before impregnation and perforated after. In *Phæocordylis*, the hairs in which the fruits are imbedded resemble the paraphyses of *Neckera*. Griffith's view of the structure of the family is seen more distinctly from the character of *Balanophora*: *Flores diclines* (*rarissime monoclines*); ♂ *bracteati, perigonio* 3—5 *sepalo valvato, staminibus totidem monadelphis bilocularibus* (*in unica specio multilocularibus*); ♀ *ovariis nudis stipitatis, receptaculo apice incrassato-glanduloso affixis, stylo setaceo persistente, stigmate inconspicuo,*

fructu pistilliformi sicco. From the Balanophoreæ, Griffith excludes *Sarcophyte*, the affinity of which is unknown, perhaps tending towards the Urticaceæ, and *Mystropetalon* Harv., which exhibits some affinity to *Cynomorium* alone, and must be regarded either as a distinct family (*planta sui ordinis*), or as a doubtful form of Loranthaceæ, with a homogeneous embryo. Both genera are accurately described from Harvey's specimens. The description of *Sarcophyte* differs very considerably from that usually given (thus: *columnæ stamineæ* 3 (— 4), *antheris indefinitis unilocularibus stipitatis*), but Endlicher has already made the same remarks regarding the structure of the stamens.

THYMELEACEÆ. New genera from Guiana, in Schomburgk's collection: *Lasiadenia* Benth. (Lond. Journ. of Bot. 1845, p. 632), and *Goodallia* Benth. (ib. p. 633).

SANTALACEÆ. Griffith states, that in *Osyris* the development of the ovule, which in other respects resembles that of *Santalum*, the embryo-sac grows out from the nucleus, and, as in *Avicennia*, the albumen is only deposited in this projecting portion (Proceed. of Linn. Soc., Nov. 1844, in Ann. Nat. Hist., xv, p. 197).

LORANTHACEÆ. R. Brown forms the Myzodendreæ from *Myzodendron*, and gives them the following characters: *Ovula* 3, *in apice placentæ centralis suspensa, unum fertile* (approximating the Santalaceæ in this character); *flos* ♂ *nudus; appendices plumosæ in* ♀ *et embryo indivisus, radicula ex albumine exserta* (Linn. Trans., xix, p. 232.)

POLYGONACEÆ. New genera: *Pteropyrum* Jaub. Sp. (Illustr. or. t. 107-9), endemic in Persia and Arabia; *Thysanella* Gray (Pl. Lindheimer) = *Polygonum fimbriatum; Symmeria* Benth. (Lond. Journ. of Bot., 1845, p. 630), a diœcious tree from Essequibo.

CHENOPODIACEÆ. *Sarcobatus* N., is figured in the American edition of Frémont's Exploring Expedition, as *Fremontia* (tab. iii). New genera: *Pterochiton* Torr., Fré. (ibid. &c. p. 57), from the west of North America; *Physogeton* and *Halothamnus* Jaub. Sp. (Ill. or. t. 135-6), from Persia.

URTICACEÆ. Gasparrini separates the following species generically from *Ficus* (Ann. Sc. nat., iii, p. 338-48): *Tenorea* = *F. stipulata; Urostigma* = *F. religiosa* and six other species; *Visiania* = *F. elastica; Cystogyne* = *F. leucosticta; Galoglychia* = *F. Saussureana*, D. C. and *galactophora* Ten.; *Covellia* = *F. ulmifolia*. He also regards *F. Carica*, at the same time attributing too much weight to the circumstance of Cynips Psenes living only on the wild fig-tree (*Caprificus*), as consisting not merely of two different species, but two genera, which he distinguishes as *Ficus* = *F. Carica fœmina* L. and *Caprificus* = *F. Carica androgyna.*

SAURURACEÆ. Decaisne describes *Spathium chinense* Lour., and forms the genus *Gymnotheca* from it (Ann. Sc. nat., iii, pp. 100-2).

PIPERACEÆ. Miquel has published a very copious supplement to his

monograph, which is composed from Hooker's herbarium (Lond. Journ. of Bot., 1845, pp. 410-70).

CONIFERÆ. Koch read a paper on the Diagnosis of the European Species of Pine, before the Association of German Naturalists (Ratisbon Flora, 1845, pp. 673-83).—The new genus, *Micocachrys* J. D. Hook. (Lond. Journ. of Bot., 1845, p. 142), has been mentioned above.

GNETACEÆ. We are indebted to the investigations of C. A. Meyer for a profound monograph of *Ephedra*, an extract from which, containing the diagnoses of nineteen new species, has appeared during the past year (Bullet. Pétersb., v. 33-36).

CYCADEÆ. Link endeavours to show that the position of the Cycadeæ beside the Coniferæ is untenable, and that they are more nearly related to the Palms (Ratisbon Flora, 1845, p. 289). Independently of the embryo, Schleiden's observation of the cambial layer beneath the bark (Grundzüge der Bot., 2, Ausg. ii, p. 152), also completely opposes these views. Link considers the leaves of the Cycadeæ, in accordance with Miquel's views, as axial organs. Miquel has explained his views upon the flowers, and especially the ovule and embryo of the Cycadeæ, more clearly than in his monograph, and has illustrated his investigations by plates (Ann. Sc. nat., iii, 3, pp. 193-206, pl. 8-9). He raises several objections to the view that the unilocular anthers are mere cells of anthers. They grow out like anthers, from the spadix; like them are surrounded by a layer of spiral cells, open by a fissure; are sometimes separated from each other by rows of hairs, and develope the pollen in the same manner as the unilocular anthers of other plants; but all these conditions apply also to dimidiate anthers, as in *Salvia*, so that the cells of the anthers of the Cycadeæ only differ from the latter in their greater number. Although the development of the embryo of the Cycadeæ has not yet been observed, nevertheless, from the comparison of the ovule with the seeds, and from the development of the former in the unimpregnated state, it appears certain that impregnation takes place according to the same law as in the Coniferæ. But since the main principle of the natural system of botany depends essentially upon the reproductive organs, we thus have a well-defined and peculiar character of the Gymnosperms in opposition to all other Phanerogamia, as also the Loranthaceæ with naked seeds—viz. that the embryo is not developed immediately from the pollen-tube, but from the terminal cell of a cellular cord, the funiculus (R. Br., embryo-blastanon Hart., Miq.), which, after impregnation, proceeds from peculiar receptacles of the embryonic vesicles (*corpuscula* R. Br.) into the endosperm. The unimpregnated ovule of the Cycadeæ differs from that of the Coniferæ in the separation of several enveloping layers of cells, the innermost layer of which contains spiral vessels, so that they appear to correspond rather with the idea of an arillus than an integumentary system, as Miquel supposes (*stratum externosum carnosum, secundum ligneum, tertium = textus cellularis*

laxus intus spiroideis vasis pertensus). The view that these cellular layers are formed before the nucleus requires confirmation, and probably only depends upon the observation not being commenced sufficiently early. In the upper persistent portion of the ovule, or the nuclear tubercle (amnios R. Br., nuclear tubercle Schleid.), Miquel has found two or more embryoblastic vesicles (*cavitates* Miq., *corpuscula* R. Br.) arranged around the axis of the organ, passing unnoticed Schleiden's description of the Coniferous ovule, according to which these originate in the upper portion of the endosperm. He expressly states that the nuclear tubercle, or rather the embryoblastic vesicles, correspond to the embryo-sac, and not to the cavity in which the albumen is formed, which, according to his view, would therefore be albumen formed within the nucleus. He regards the nuclear tubercle as "a compound amnios" the "individual embryo-sacs" of which would be the embryoblastic vesicles. Moreover, Miquel has shown in the seeds the connexion of the coiled funiculus with the embryoblastic vesicles, as also the anastomoses of the former; and lastly, has found that the form of the embryo is different in all the four genera, by which circumstance they may be distinguished. In the supplement (iv, p. 79), although he has never been able to discover the embryoblastic vesicles in the unimpregnated ovule, he admits the truth of R. Brown's observations (Ann. Nat. Hist., 1844, May), according to which it may be formed independently of impregnation. This observation is confirmed by the corresponding statements of Gottsche (Bot. Zeit. 1845, p. 402), who has written a detailed critical memoir upon the inflorescence of the Cycadeæ and the Coniferæ (ibid. Nos. 22-27), in which his observations were extended to living Cycadeæ. According to Gottsche, the embryoblastic vesicles, which in *Cupressus* are merely simple enlarged cells of the endosperm, in *Macrozamia* and *Encephalartos*, in which they are 1‴ in length and about ½‴ in breadth (pp. 399-400), possess a cellular wall, which, however, may constitute a later stage of development. Gottsche has not, however, succeeded in bringing into accordance the contradictory views upon the function of these sacs in the act of impregnation by new observations; although, in opposition to Hartig and in favour of Schleiden, he believes (p. 417) that the pollen-tubes penetrate the embryoblastic vesicles in the Cycadeæ also. Although I have no hesitation in admitting that this point has been satisfactorily determined by observation in the Coniferæ, yet there is a wide interval, which has not yet been filled up, before we can arrive at Schleiden's view, that the pollen-tube is prolonged inwards as far as the embryo-blaston itself, with which neither the illustrated descriptions of Brown or Miquel of the origin of the embryo-blaston, from a spherical cell inclosed in its vesicles, and resembling a pollen-granule, can be brought into connexion. These two figures, one of which is taken from the Coniferæ, the other from the Cycadeæ, agree so completely that they cannot be doubted. In my opinion they only admit of one interpretation,

that in the pre-formed embryoblastic vesicles, the apex of the pollen-tube only produces a primary embryonal cell; and that at a subsequent period long after the pollen-tube has been destroyed, this grows into the embryoblaston in the same manner as the pollen-tube does at first from the pollen-cell. In accordance with this hypothesis, the simplest expression of the impregnation of the Gymnosperms would be found in their embryo not being formed in the pollen-tube itself, but in the apex of one of its secondary cells, the development of which does not commence until a long period after it had lost its parent-cell.

PALMÆ. The eighth part of V. Martius's large work on the Palms has appeared, (Monach. 1845, fol.,) containing the conclusion of the text, a Memoir upon Fossil Palms, by Unger, and the commencement of the morphology of the family from the pen of Martius himself. The text includes the completion of *Phœnix* and the Cocoineæ. The contents of the morphological section, in which at present the stem and the formation of the leaves are treated of, are more histological and physiological than systematic. The fibrous root formed during germination is soon succeeded by the formation of the rhizome from an axillary system of branches of the base of the stem (§ 23) with new radicles, which may protrude through any part of the cortical layer of the rhizome (§ 24) whilst the branches of a higher order arise only from the axillary buds of the rudiments of the leaves of the rhizome, and therefore, like the stem, they only possess the vascular bundles of the leaves, and not unfrequently grow into turiones. After the earlier radicles are dead, the older palm-stem rests upon adventitious roots, which arise laterally from the lower part of the stem, generally in the vicinity of the scars of leaves; which contradicts Schleiden's explanation of this phenomenon. (Grundzüg. i, Ausg. 2, p. 122.) The structure of the stem is very fully described. The results agree essentially with those of Mohl: the remark that the vascular bundles do not always return to the bark on the same side of the stem as that upon which the corresponding leaf is situated, but on the opposite side, so that they traverse the entire stem in an oblique direction, is new. The vascular tissue of the root appears to be different from that of the stem. The morphology of the leaf is not yet completed, and partly differs, in the *genesis*, from Mirbel. It appears clear, from the plates, that the segments are really formed by the subdivision of a simple lamina. The course of the lateral vascular bundles indicates the segments even when the lamina is simple.

TYPHACEÆ. Schnitzlein has described this group. (Die Natürl. Familie der Typhaceen mit besonderer Rücksicht auf die Deutschen Arten. Nördlingen, 1845, iv, p. 28.) The morphological considerations are based upon an accurate investigation of the structure of *Typha angustifolia* and *Sparganium natans*. The author considers the Typhaceæ as more closely allied to the Cyperaceæ than to the Aroideæ, which is, however, at variance with the

structure of the seed. He regards the sterile stamens as perigones, which must be rigidly shown by the history of their development.

ORCHIDACEÆ. New genera: *Dialissa* Lindl., (a century of new genera and species of Orchidaceous plants, in Ann. of Nat. Hist., xv, p. 107,) allied to *Stelis*, from New Granada; *Helcia* Lindl. (Bot. Reg. 1845, Misc. p. 18), near *Trichopilia*, from Guyaquil; *Porpax* Lindl. (ib. p. 63), near *Eria*, from the East Indies; *Galeottia* Rich. Galeott. (Orchidographie Mexicaine, in Ann. Sc. Nat. iii, 3, p. 25), near *Maxillaria; Galeoglossum* and *Ocampoa*, Rich. Gal. (ib. p. 31), two Neottieæ. Lindley has given systematic notices of *Miltonia*, (Bot. Reg. t. 8), of *Odontoglossum* (ib. Misc. p. 49-59), and of several sections of *Epidendrum* (ib. pp. 22-9 and 65-79): the Monograph last mentioned, which was commenced some time since, is thus completed.

IRIDACEÆ. Herbert has continued his description of *Crocus*. (Bot. Reg. 1845, t. 37, and Misc. pp. 1-8, 31, 80-3.)

TACCACEÆ. This new genus, *Thismia*, Griff., from Tenasserim, borders closely upon this group, (having a remarkable affinity with *Burmannia*), it is a monocotyledonous representative of the Rhizantheæ. (Linn. Transact. xix, p. 343.)

AMARYLLIDACEÆ. Herbert separates *Phædranassa* Herb. = *H. dubius* Knt., from *Hæmanthus*. (Bot. Reg. 1845, Misc. p. 16.)

LILIACEÆ. New genus: *Chrysobactron* J. D. Hook. (Antarct. Voy., p. 72, pl. 44, 45), vide supra. Lindley has written a short Monograph of the New Holland genus, *Blandfordia*. (Bot. Reg. 1845, tab. xviii.)

JUNCACEÆ. Decaisne has described a diœcious plant *Goudotia*, new genus, growing upon the Andes of New Granada, at an elevation of 5000 meters, and forming a turf; he arranges it among the Juncaceæ, (Ann. Sc. Nat. 3, 4, p. 84), from which it differs in its coloured six-partite perigone, which is surrounded by a tripartite involucre; the position assigned to it above, especially as the structure of the seed is not known, can, therefore, only be regarded as provisional.

CYPERACEÆ.—Schlechtendal has published some remarks upon *Scleria* (Bot. Zeit., 1845, Nos. 28, 30).

GRAMINACEÆ.—Mohl considers the 2 paleæ as the products of different axes, and thus endeavours to overthrow R. Brown's theory of the flowers of Grasses, in which a viviparous monstrosity of *Poa alpina* formed the basis of the argument supporting his view (Bot. Zeit., 1845, pp. 33-7). I have endeavoured to defend the view that these organs are bracts (Gott. gel. Anz., pp. 683-7). Parlatore has formed the genus *Antinoria* of *Airopsis agrostidea* D. C., *Aira agrostidea* Guss. (Fl. palermit, i, p. 92).

FERNS.—The eighth part of the first volume of Kunze's illustrated work (Die Farnkräuter in colorirten Abbildungen, Leipsig, 1845, p. 4), has been published, containing pl. 71-80.—Presl has written a supplement to his Pteridographia, in which the number of genera and species appears to be

considerably increased (Supplementum tentaminis Pteridographiæ, continens genera et species ordinum q. d. Marattiaceæ, Ophioglossaceæ, Osmundaceæ Schizæaceæ et Lygodiaceæ. Pragæ, 1845, 4to, pp. 119). The third part of Sir W. Hooker's Species filicum is issued from the press, and contains twenty plates. J. Smith has separated some species of *Oxygonium* from the Archipelago, as *Syngramma* (Lond. Journ. of Bot., 1845, p. 168).

Mosses.—Nägeli has written a valuable memoir, entering fully into physiological details, upon the growth of the vegetative organs in Mosses and Hepaticæ (Zeitschr. für wissenschaftl. Bot., Hft. 2, pp. 131-209), from which he arrives at the systematic conclusion, that the formation of the leaf of Mosses is subject to a peculiar law; the point of the organ is formed last, the base first, by the formation of cells, whilst the growth of the individual cells ceases sooner at the point than at the base of the organ. Regarding their germination, Nägeli remarks (p. 175), that it is the same as in the Ferns; in both, the axis is formed from a single parent-cell of the pro-embryo, whence, "the earlier view that the pro-embryo forms a tissue, and that the stem is formed from this tissue by the growth of numerous cellular threads is contradicted." However, in both families these parent-cells are only capable of growing upwards, whence it follows, that all the roots have a lateral origin, but not, as Schleiden believes, that no roots are present. Just as the first axis of the Moss is developed from a parent-cell of the pro-embryo (germinal spore-filament of Nägeli), in the same manner in *Phascum*, for instance, the formation of new axes from certain capillary radicles (germinal bud-filament of Nägeli), whilst other similarly-formed roots do not appear to possess this formative power, and are therefore the only true roots, according to Nägeli's views.—Bruch and Schimper, now in conjunction with Gümbel also, have published the genera *Schistidium*, *Grimmia*, and *Racomitrium*, in four parts of their history of European Mosses (Bryologia Europæa. Fasc., pp. 25-8. Stuttg., 1845, 4to). Hampe has commenced an illustrated work, with the following title: Icones Muscorum Novorum v. minus Cognitorum (Dec. 1-3. Bonn., 1844-5, 8vo). C. Müller has given a review of *Macromitrium* (Botan. Zeit., 1845, Nos. 32, 33).—New genera: *Garckea*, C. Müll. (ibid., p. 865), from Java; from Chili, *Leptochlæna*, Mont. (Cinq. Centurie de planches cellulaires exotiques nouv., in Ann. Sc. Nat. iii, 4, p. 105), *Aschistodon* (ib. p. 109), *Diplostichon* (ib. p. 117), = *Pterigynandrum longirostrum* Brid., and *Encamptodon* (ib. pp. 120-36. pl. 14); from Lord Auckland's islands, *Sprucea* W. J. Hook. = *Holomitrium*, Brid., and *Lophiodon*, W. J. Hook. = *Cynodon*, Brid. (Antarct. Voy.)

Hepaticæ.—Of the 'Synopsis Hepaticarum,' edited conjointly by Gottsche, Lindenberg, and Nees v. Esenbeck, the second and third part appeared in 1845, and the fourth part, which brings this important work to a conclusion, in 1846, excepting a supplement which remains to be added (Hamburg, viii, 624 pp.) The following new genera are distinguished in them: *Acrobolbus* N.

from Ireland; *Gottschea* N. = Junc. Sect. nemerosæ aligeræ; *Sphagnœcetis* N. = *J. Sphagni* Dics. and others; *Liochlaena* N. = *J. lanceolata; Micropterygium* = *J. Pterygophillum*, &c.; *Polyotus* G. = *Junc. sp.* Hook. and Tayl., from the South Sea; *Thysananthus* Ld. = *Trullania* Sect. *Bryopteris; Omphalanthus* = Jung. sp. American, &c.; *Androcryphia* N. = *Noteroclada* Tayl., *Carpolipum* N. = *Carpobolus* Schwein.

Lichens.—Montagne describes the new genus *Stegobolus* from Cumming's collection from the Philippine Isles (Lond. Journ. of Bot., 1845, p. 4). The new *Myriangium*, described by Montagne and Berkeley, belongs to the Collemaceæ; it is found in the Pyrenees, Algiers, and the Swan River (ib. p. 72); it forms a transition to the Fungi, resembling externally a *Dothidea*.

Algæ.—After the tetraspores of Florideæ had been pointed out in the Fucoideæ, Montagne was the first to find them also in one of the Confervæ, the genus *Thwaitesia* Mont. discovered in Algiers by Durieu, which only differs from *Zygnema* in this character (Compt. rendus, 1845, Oct.); however, the genus has since been rendered doubtful by the discovery of tetraspores also in several other Zygnemeæ (Revue Botan., 1846, p. 469). Decaisne and Thuret have been engaged in the investigation of the antheridia of the Fucoideæ, and have shown that the contrast between them and the sporangia is as great as in the *Charæ* or Mosses (Ann. sc. nat. iii, pp. 5-15, pl. I, II).—C. Müller has investigated the history of the development of the *Charæ* (Bot. Zeit., Nos. 24-7, pl. III). The large cell of the sporangium, filled with starch, should be regarded as a spore surrounded by a capsule, consisting of two layers of cells, which, on germination, protrudes through its envelopes (figs. 4, 6). Even before this a cytoblast appears in the place of the starch, hence the turbid fluid existing in a smaller cell situated beneath the spore, and inclosed with it in the sporangium (figs. 1, 2), probably plays an important part. From the commencement, the axis developes itself, although a mere cellular thread, in two opposite directions, as root and stem; this has been observed by Kaulfuss, and Nägeli has shown the same thing in the case of the cell of *Caulerpa*. At a subsequent period, "new" individuals are developed from the adventitious roots of the lower cells of the stem (turiones, according to fig. 10). At a much later period the whorled branches and cortical cells of the stem of *Chara* are developed, which the author has traced into the terminal bud; the former arise from the longitudinal subdivision of the cellular contents of the terminal cell (fig. 12), the latter from a growth of the branch just as in the Batrachosperms.—Fresenius has published a memoir upon the structure of the Oscillatoriæ, in which a critical history of the observations relating to these plants is contained (Mus. Senckenberg, iii, pp. 263, 292).—New genera of Algæ: Fucoideæ: *Cymaduse* Decs. Thur. (Ann. sc. nat. iii, 3, p. 12) = *Fucus tuberculatus* Huds.; *Pelvetia* D. Th. (ib.) = *F. canaliculatus; Ozothallia* D. Th. (ib.) = *F. nodosus* L. (*Physocaulon* Kütz.), so that *Fucus vesiculosus* and *serratus* are all that remain in the genus; *Pinnaria*

Endl. Dies. (Bot. Zeit., 1845, p. 288), near *Laminaria*, from Port Natal; *Contarinia* Endl. Dies. (ib. p. 289), from the same locality, near *Scytothalia; Stereocladon* Hook. Harv. (Lond. Journ. of Bot., 1845, p. 250), from Antarctic America; *Scytothamnus* Hook. Harv. (ib. p. 531)=*Chordaria Australis* Ag., from New Zealand. Florideæ: the Sphærococcoideæ, *Dicranema* Sond., from the Swan River (Bot. Zeit., 1845, p. 56), *Sarcomenia* Sond., also from this locality (ib.), *Phalerocarpus* Endl. Dies., from Port Natal (ib. p. 290), *Acanthococcus* Hook., Harv., from Antarctic America (l. c. p. 261), and *Hydropuntia* Mont., which was proposed on a former occasion, but is now fully described, and placed in this group as an aberrant form (Voy. au Pôle Sud.—Bot., i.p. 166, pl. 1); of the Rhodomeleæ: *Lenormandia* Sond. nec Mont., *Kützingia* Sond., and *Trygenea* Sond., from the Swan River (l. c. p. 54), *Epineuron* Harv., from New Zealand = *Fucus lineatus* Turn., &c. (l. c. p. 352); *Cladhymenia* Harv. (Lomentariæ), from New Zealand (ib. p. 530); *Apophlæa* Harv. (Cryptonemeæ), from New Zealand (ib. p. 549), and *Gelinaria* Sond., from the Swan River (l. c. p. 55); the Ceramiæ, *Hanowia, Ptilocladia,* and *Dasyphila* Sond., from the Swan River (l. c. pp. 52, 53). Confervaceæ: the Siphoneæ, *Struvea* Sond., from the Swan River (l. c. p. 49), *Cladothele* Hook. Harv., from the Falklands (l. c. p. 293), *Derbesia* Solier = *Bryopsidis* sp. (Rev. Bot. i, p. 452), and *Arechougia* Meneg., one of the Confervoideæ = *Phycophilæ* Kütz. sp. et *Confervæ* auctor (Atti di vi, riunione, p. 456).

Fungi.—The illustrated work of Harzer is completed by the sixteenth part (Naturgetreue Abbildungen der vorzüglichsten, essbaren, giftigen und verdächtigen Pilze. Heft xvi, Dresden, 1845, 4to).—New genera and monographic descriptions. Pyrenomycetes: De Notaris separates the following types from *Sphæria: Venturia, Massaria* = *Sp. inquinans,* Tod., *Rosellinia* = *Sp. aquila,* Fr. *Bertia* = *Sph. moriformis* Tod. (Atti di vi, riunione, pp. 484-7, t. i). Léveillé describes *Lembosia* and *Asterina* (Champign. exotiques in Ann. Sc. nat. iii, 3, pp. 58-9); Montagne, the new Pezizoideæ, *Hymenobolus,* from Algeria (ib. iii, 4, p. 359), and *Aserophallus,* from Cayenne (ib. p. 360). Gasteromycetes: Montagne describes *Xylopodium* and *Lasioderma,* from Algeria (ib. p. 364), and Czerniaïew, the following from Ukraine, *Endoptychum* (Bull. Mosc., 1845, ii, p. 146); *Trichaster* (ib. p. 149); *Endoneuron* (ib. p. 151); *Disciseda* (ib. p. 153); and *Xyloidion* (ib. p. 154). The two Tulasnes have written a monograph upon the Tuberaceæ, *Choiomyces* Vitt., and *Picoa* Vitt. Berkeley has described *Podascon pistillaris* Fr., from the Cape de Verd Islands (Lond. Journ. of Bot., 1845, pp. 291-3, t. x). Hyphomycetes: *Sphæromyces* Mont., from Algiers (l. c. p. 365); Coniomycetes, *Polydesmus* Mont. (ib. p. 365); *Phylacia* Léveill. (l. c. p. 61), from the group of Cytisporeæ to that of the Coniomycetes; *Piptostomum* Lév. (ib. p. 65). *Podisoma macropus* upon *Juniperus virginiana* is described by Wyman and Berkeley (Lond. Journ. of Bot., 1845, pp. 315-19, t. 12).

EXPLANATION OF THE PLATES.

MOHL ON THE PALM-STEM.

PLATE I.

Figs. 1—8. Young leaves from the terminal bud of *Cocos flexuosa*, in which the gradual production of the pinnæ is to be seen. The figures marked *a* represent the leaflets of the natural size; those marked *b*, the same magnified. Originally (figs. 1, 2) a shallow furrow occurs at the margin of the leaflet; afterwards (figs. 3, 4) delicate transverse striæ appear at the bottom of the furrow; these are converted (figs. 5—8) into slits, which penetrate the substance of the leaf, and divide it into pinnæ, as may be seen in the cross section (fig. 7, *c*). The points of the pinnæ are connected by a cellular mass (fig. 8*), which corresponds to the original margin of the leaf, and subsequently withers.

Figs. 9—12. Young leaves of the bud of *Phœnix dactylifera*, in which the pinnæ originate, in like manner, through slits which divide the simple leaf.

NÄGELI ON CELLS.

PLATE II.

Figs. 1—3. *Bryopsis Balbisiana* Ag.

1. Piece of an old tube; *a* and *b*, dead contents detached from the wall, and beginning to dissolve; *c*, living contents which have become detached from the cell-

membrane, and are bounded externally by the mucilaginous layer; *d*, living, unaltered contents, lying upon the walls; *e*, mucilaginous cord, the remains of the mucilaginous layer formerly clothing the points *a*; it connects *c* and *d*.

2. The same piece of tube as in Fig. 1, a short time after. The mucilaginous cord (1, *e*) is torn in two, and has become united with the two living portions of contents (*c* and *d*).

3. Piece of an old tube, in which the whole contents have become detached from the membrane; the greater part is dead and beginning to dissolve; *a*, *a*, little, colourless, globular masses of mucilage; *b*, *b*, the same larger, granular, and of a pale green, with a delicate membrane; *c*, *c*, distinct cells, with green granular contents deposited upon the walls.

Figs. 4, 6. *Zygnema stellinum* Ag.

4. Piece of a filament, where the conjugation has not been perfectly effected. The contents have become agglomerated into a ball, and converted into a cell in each articulation, these cells exhibiting the same form as the contents accidentally possessed before the formation of the membrane. In *a* it is ellipsoidal, in *b* and *c*, furnished with a papilla corresponding to the blind process.

6. Two articulations of distinct filaments which have conjugated. The contents of both articulations had been transformed into cells before the union. The contents of the articulation *a* have become an ellipsoidal cell. The contents of *b* have produced a cell in the same form which they possessed during their passage through the tube of communication.

Fig. 5. *Spirogyra quinina* Link.

Piece of a filament in which the germ-cells form without congregation. The contents have been loosened from

the membrane. In *a* and *b* the nucleus lies outside the contents. In *c* the nucleus has been dissolved.

Fig. 7. *Scilla cernua* Red.

Formation of the nucleus in the embryo-sac.

a. A little globular drop of homogeneous, colourless mucilage, with a definite outline. Diam. =·002 of a line.

b. A similar one, with thinner mucilage.

c. A globule of mucilage like *a.* Diam. ·0025 of a line.

d, e. A larger globule of mucilage (nucleus) with an included ring (nucleolus). Nucleus and nucleolus have a similar density. Diam. of the former =·0045 of a line.

f. A nucleus with an included nucleolus of equal density. Diam. of the former =·008 of a line.

g. A nucleus with two included nucleoli of equal density. Diam. of the former =·009 of a line.

Fig. 8. *Tigridia Pavonia* Juss.

Cell-formation in the embryo-sac.

a. A globular drop of homogeneous, colourless mucilage, with a definite outline (nucleus). Diam. =·001 of a line.

b. A nucleus with scarcely granular mucilaginous contents. Diam. =·003 of a line.

c. A nucleus in which some larger granules (nucleoli) are visible. Diam. =·005 of a line.

d. A nucleus with four denser nucleoli, on which has been deposited a layer of homogeneous mucilage (cell). The mucilage of the cell is more dense than the contents of the nucleus. Diam. of the nucleus =·005 of a line.

e. A cell consisting of homogeneous mucilage, with a free (central) nucleus. The contents of the latter are less dense than the mucilage of the cell; it includes four denser nucleoli. Diam. of the cell = ·010 of a line.

f. A cell composed of almost homogeneous mucilage, with a lateral nucleus. Diam. of the cell = ·315.

g. A cell, in which a delicate membrane is distinctly visible outside the finely granular contents. The nucleus possesses five nucleoli; its contents are less dense than those of the cell. Diam. of the cell = ·020 of a line.

Fig. 9. *Formation of the nucleus in the embryo-sac in various plants.*

a. A nucleus with a lateral nucleolus of brighter (less dense) substance. Diam. of the nucleus = ·004 of a line.

b. A nucleus with a nucleolus of denser substance. Diam. of the nucleus = ·005 of a line.

c. A nucleus with a nucleolus, both consisting of homogeneous mucilage of the same density.

d. The same nucleus altered by the injurious influence of water. The mucilage of nucleus and nucleolus has become more dense; a vacant space (filled with water) has formed around the latter. Diam. of the nucleus = ·009 of a line.

e. A nucleus with three nucleoli, both consisting of equally dense, homogeneous mucilage.

f. The same nucleus altered by the injurious influence of water. A transparent space has formed around each nucleolus. The contents of the nucleus and nucleoli have contracted. Diam. of the nucleus = ·010 of a line.

g. An abnormally altered nucleus, like *d* and *f*.

h. An abnormally altered nucleus, like *d* and *f*.

i. The same nucleus a short time after. The membrane expands out into a vesicle at one side in consequence of the endosmose of water.

k. The same nucleus later still; the vesicle has become still larger.

l. An abnormally altered nucleus with two nucleoli, the membranes of which have, in like manner, expanded out into a vesicle on one side, as in *i* and *k*.

m. An abnormally altered nuclens with one nucleolus, the membrane of which has merely expanded into a vesicle at one small point.

PLATE III.

Figs. 1—8. *Achlya prolifera* Nees.

Clavate expanded extremities of the branches.

1. Part of the contents form an elliptical accumulation, which loses itself pretty gradually, externally, in the remainder of the cell-contents, and from which radiating threads of circulation proceed.

2. The elliptical accumulation presents a better defined outline; there are still some few threads of circulation.

3. The agglomerated portion of contents has become converted into a cell (sporangium) by the formation of a membrane. This is densely filled with granular mucilage.

4. The sporangium-cell is filled with dark, granular contents, and inclosed by a tolerably thick membrane. It has grown out, upward, and downward, into two processes (branches). These have a delicate membrane and contents, consisting of mucilage, homogeneous towards the summit at least. They elongate by apical growth.

5. Three free sporangial cells have been formed in the end of a branch. They contain homogeneous mucilage.

6. Two free sporangial cells, each of which has grown out into a process. One sporangium is densely filled with minute cellules. The other has already discharged the greater part of the motile cellules through the opening of the apex of the process.

7. The entire end of the branch has become a sporangium, the whole of the contents having become isolated and converted into a cell by parietal cell-formation. This is filled with granular mucilage.

8. As in fig. 7. The sporangium has grown out at the apex into a short process. It is crowded with minute cellules.

Figs. 9, 10. *Griffithsia corallina* Ag.

9. Terminal cell of a stem, ·080 of a line long, ·040 broad. The cavity is filled with transparent, colourless fluid. The wall is coated by a layer of dull brownish-red contents, except at the apex, where a slightly coloured, finely granular mucilage lies upon the membrane.

10. The terminal cell has divided into two secondary cells by parietal cell-formation. The lower one contains transparent, colourless fluid, and is coated with a layer of dull brownish-red contents. The upper, smaller cell, has upon its walls a distinct layer of slightly coloured, finely granular mucilage, and is filled internally with a dull-red granular mass. (If the cell becomes larger, the almost colourless mucilaginous layer diminishes on the lower and lateral walls, so that it can no longer be clearly distinguished, it only remains distinctly evident at the growing point. The remaining—dark red, granular—contents divide with the growth of the cell in the interior, and remain lying upon the wall.)

UTRICULAR STRUCTURES.

PLATE II.

Figs. 10, 11. Chlorophyll-utricles from the pro-embryo of *Pteris nemoralis* Willd.

10, *a*, *b*, *c*. In normal conditions: they possess a distinct membrane, homogeneous green contents, and starch-granules, which have become coloured blue by the commencement of the action of an aqueous solution of iodine upon them. *a*. A round chlorophyll-utricle with two starch-granules. Diam. of the utricle = ·003 of a line. *b*. A longish chlorophyll-utricle with one starch-granule. *c*. A chlorophyll-utricle which has divided into two secondary utricles by means of a septum.

10, *d, e, f*. Chlorophyll-utricles in decaying cells of the pro-embryo. They lie free in the cavity of the cells, and have become abnormally altered before their complete solution. They are globular, and the membrane may be clearly distinguished from the fluid contents mingled with minute granules. *a*. Contents still of a light green colour. Diam. =·0035 of a line. *b*. Contents likewise slightly green. Diam. =·005 of a line. *c*. Contents colourless and transparent, with minute granules. Diam. =·008 of a line.

11. Parietal chlorophyll-utricles which, from their crowded position, form a parenchymatous layer. They are filled with homogeneous chlorophyll, and inclose one or two starch-granules, which have become blue from the commencement of the action of aqueous solution of iodine.

12. Chlorophyll-utricles from the parenchyma of young leaves of *Begonia dichotoma* Jacq. In *b*—*h* the starch is coloured blue, from the commencing action of iodine.

a. An utricle with homogeneous green contents. Diam. =·003 of a line.

b, c. Utricles with four and three minute starch-granules.

d, e, f. Utricles with a solitary larger starch-granule.

g. An utricle with three larger starch-granules, parenchymatously connected through pressure.

h. An utricle with two larger starch-granules flattened by mutual pressure.

i, k, l. Utricles with one large starch-granule, which has now more or less displaced the chlorophyll.

m. A starch-granule become free through the absorption of the chlorophyll-utricle.

n. A group of three starch-granules, connected together by adhesion, become free after the absorption of the chlorophyll-utricle.

13. Chlorophyll-utricles from a cell of *Conferva glome-*

rata L., var. *lacustris*. They lie in one of the reticular circulation-filaments, upon the wall, and have become parenchymatous, from their crowded position. Some (*a*) contain only homogeneous chlorophyll. Others possess, in addition, a small or large starch-granule, which is coloured blue by the action of iodine.

14. Starch-utricles (starch-granules) from the corm of *Crocus vernus* Willd. They have an angular form. Iodine has coloured the starch-layers blue, but not affected the original membrane. Diam. = ·004 of a line.

15. Starch-utricles (starch-granules) from the peduncles of *Vitis vitifera*, with very evident membrane and large cavity. The starch-layers have become coloured blue by iodine; the original membrane remains uncoloured.

16. Chlorophyll-utricles, from a cell of *Conferva glomerata* L. var. *marina*. They lie in rows in the parietal circulatory reticulation, and have expanded lengthways in the direction of the current. The utricles lying in the angles of the network exhibit elongated processes toward the lines of the net. In each utricle lies a starch-granule.

17. Chlorophyll-utricles, from *Nitella*, with a colourless membrane and homogeneous contents, and with from two (*a*) to five (*b*) starch-granules.

18. Mucilage-utricles from *Nitella*.

a. With homogeneous mucilage and smooth membrane.

b. The mucilaginous contents have become agglomerated into a ball, and separated from the wall on one side; the membrane is punctated outside.

c. As in *b*, the surface is clothed with minute spines.

d. The spines have disappeared; the surface is irregularly uneven.

e. A piece of a spinated membrane more highly magnified.

INDEX TO THE PHYSIOLOGICAL REPORT.

AUTHORS.

SUBJECTS.

INDEX TO GEOGRAPHICAL BOTANY.

PLACES.

GENERAL WORKS, 317-418.

AUTHORS.

INDEX TO SYSTEMATIC BOTANY.

GENERAL WORKS.

NATURAL ORDERS.

AUTHORS.

THE END.

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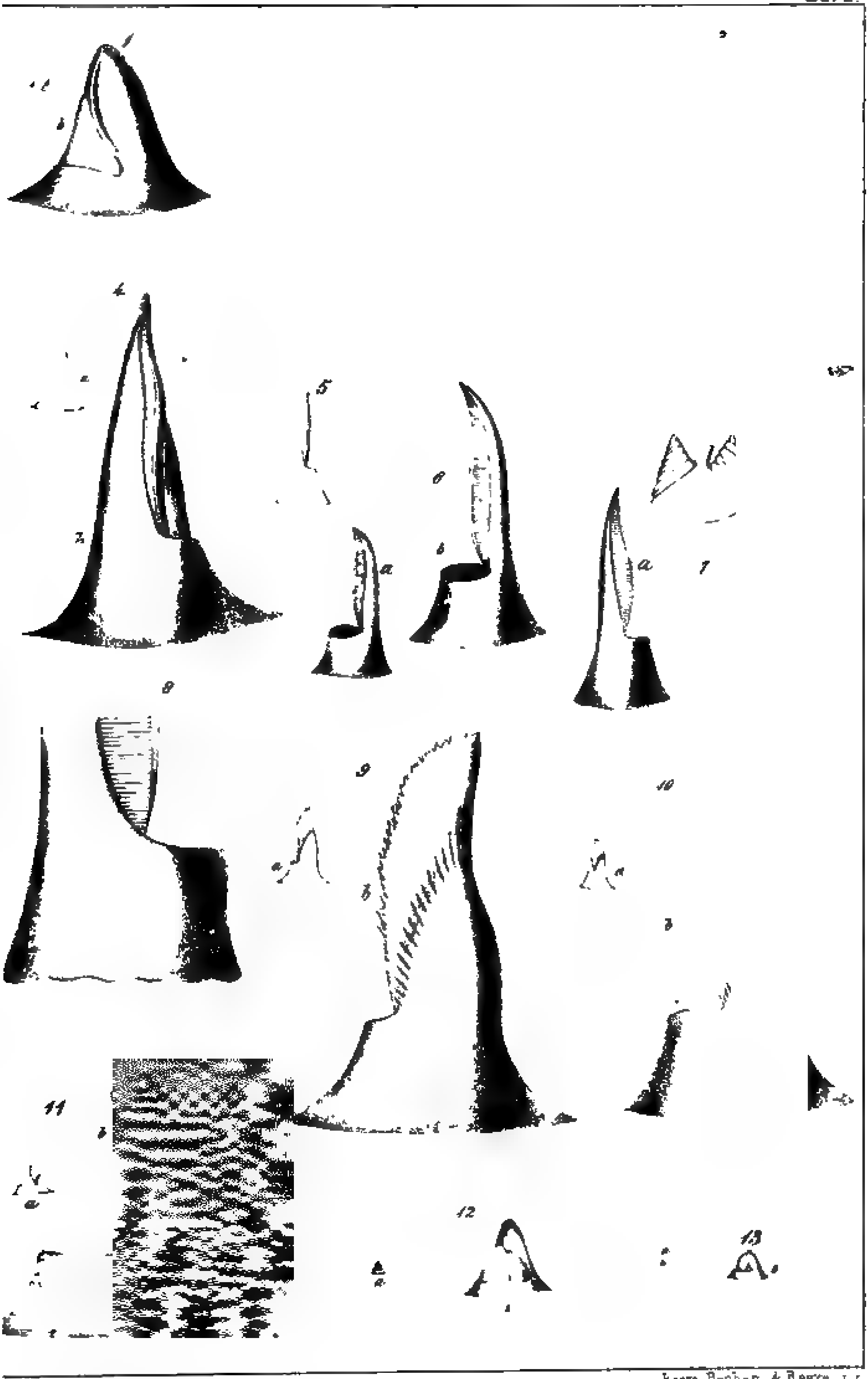
Pl. 1.



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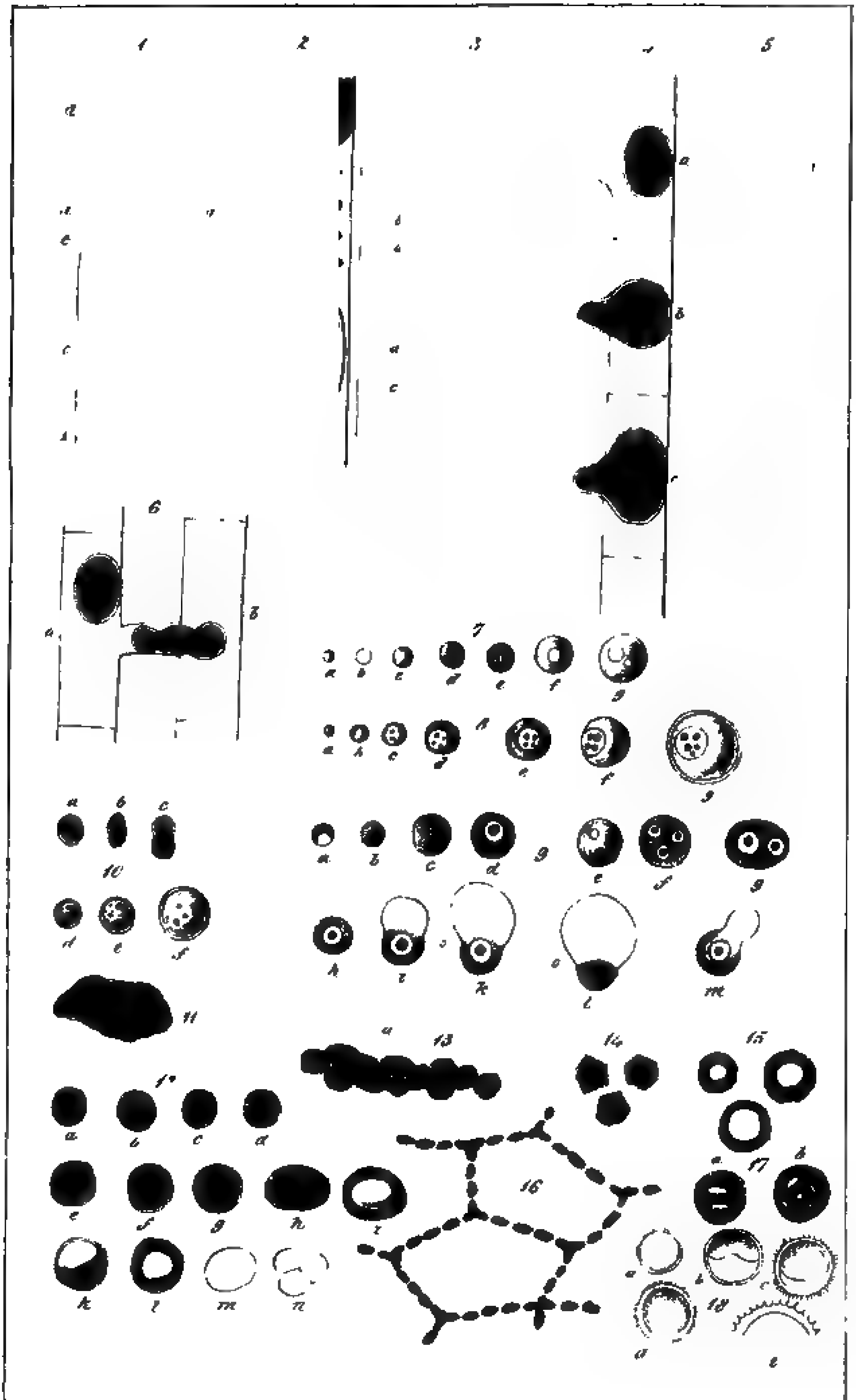

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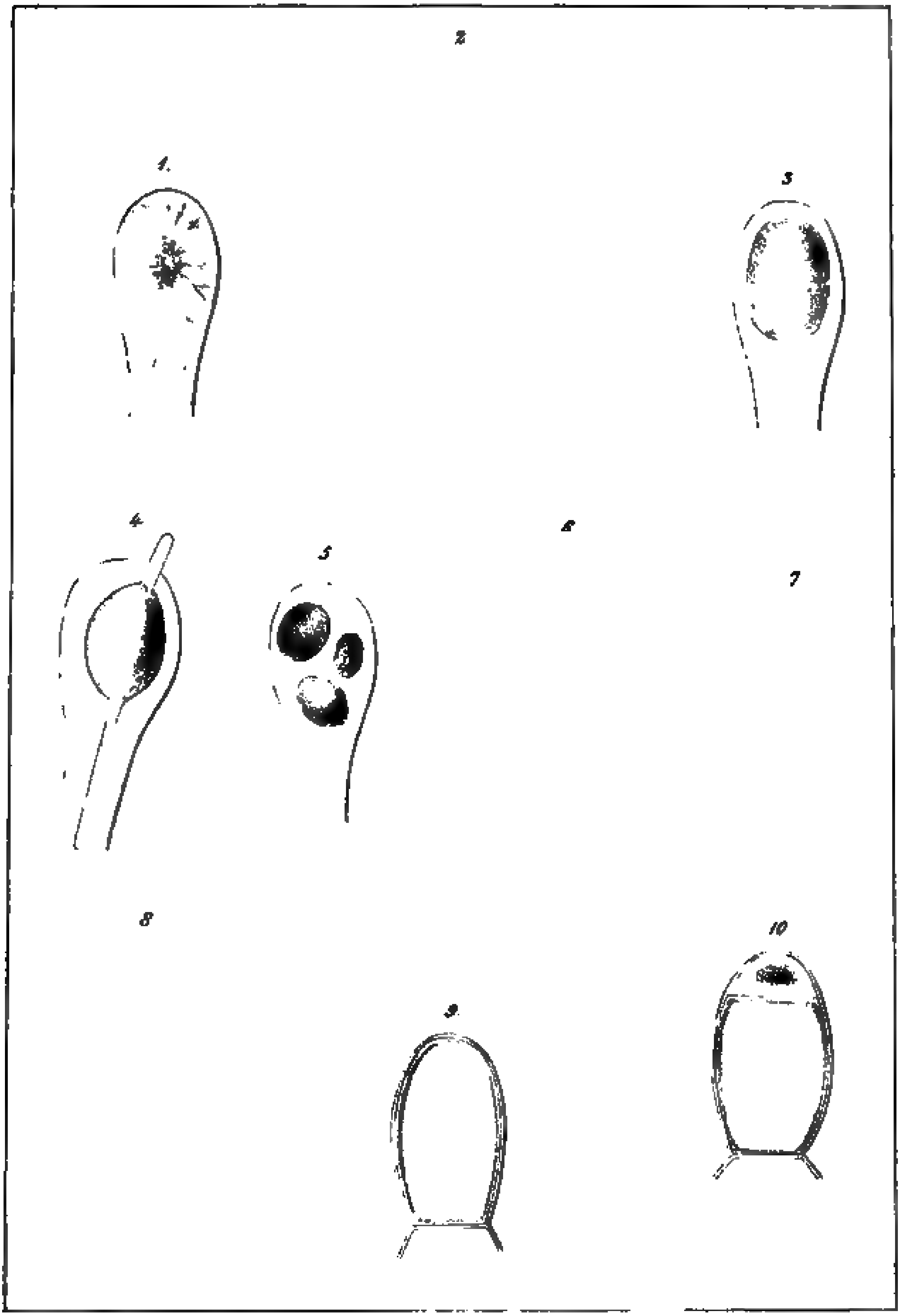

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REPORT

OF THE

COUNCIL OF THE RAY SOCIETY,

READ AT THE SIXTH ANNIVERSARY,

HELD AT BIRMINGHAM, SEPT. 17, 1849.

W. SPENCE, ESQ., F.R.S. F.L.S. &c.

IN THE CHAIR.

IN laying before the Members of the RAY SOCIETY the Sixth Annual Report, the Council feel that they have cause for the expression of satisfaction that, whilst so many societies similar to their own have suffered greatly from the loss of subscribers through the general depression of the times, the number of members has but slightly diminished, affording a gratifying proof of the continued interest excited by the publications of this Society.

From the circumstance of all the works of the Society having been ready for publication at the early part of the year 1848, and before they had put forth their last Annual Report, the Council has little to add, with regard to the works of the present year, more than was stated in their last Report. They feel it, however, incumbent on them to state to the subscribers the reason of the works not being in so forward a state as in 1848. At the beginning of that year all the works of the Society, viz. the 'Bibliographia Zoologiæ,' by Professor Agassiz; the 'Correspondence of John Ray;' and Part IV of Alder and Hancock, were ready for distribution, and the Council had made themselves liable for the cost of printing, &c.; whilst at that time not more than a fourth of the subscriptions for 1848 had been paid; and at the time of the publication of their last Report, upwards of £800 was owing to the Society for 1848 and the preceding years. The following passage from the Report of last year expressed the feelings of the Council on this point:

"*Serious inconvenience having arisen to the Council in consequence of the non-payment of the Annual Subscriptions by the Country Members, the Council beg respectfully to remind them that they have no other funds at their disposal for conducting the business of the Society than the* ANNUAL SUBSCRIPTIONS PAID IN ADVANCE, *and that it will greatly facilitate the speedy issue of their books if payment be made early in the year.*"

Although this notice has to some extent caused a more early payment of subscriptions, yet the Council have to regret that, at the present moment, a sum exceeding £500 is due to them from the country subscribers for subscriptions on the present and past years.

Under these circumstances the Council have not felt themselves justified in bringing their works out early this year; they have, however, the satisfaction of stating that a volume of Reports and Papers on Botany is now ready for distribution. This work, which has been translated under the direction, and edited by, Mr. Henfrey, consists of the following papers:

I—Mohl on the Structure of the Palm-stem.
II—Nägeli on Vegetable-cells.
III—Nägeli on the Utricular Structures in the Contents of Cells.
IV—Link's Report on Physiological Botany for 1844-45.
V—Grisebach's Report on Geographical Botany for 1844.
VI—Grisebach's Report on Geographical and Systematic Botany for 1845.

The Council regret that, with one exception now in progress, viz. Dr. Bell Salter's work on the British Rubi, they have not had the offer of any original Botanical work of importance, although they are desirous of giving to Botany a fair proportion of space in their publications. The second volume which the Council intend to issue for this year, and which is now in a state of great forwardness, is Dr. Baird's Entomostracous Crustacea. This work will consist of about 300 pages octavo, and will be illustrated by 25 Lithographic Plates by Mr. Wing, containing drawings of each species. The Council confidently believe that no one of the works published by the Society contains a larger amount of new matter, and on a subject of more interest, than that of this volume, which they hope speedily to publish.

With regard to a third volume, the Council had resolved to publish a first part of the second volume of the 'Bibliographia Zoologia,' when an offer was made to them by Professor Allman of a Memoir on the 'British Fresh-water Zoophytes,' with coloured drawings of all the species. As this work is nearly ready for publication, and as it would be almost impossible for the Society to print it either in 1850 or 1851, when it is hoped the two remaining parts of Alder and Hancock's work on the 'British Nudibranchiate Mollusca' will be published, the Council hope that Professor Allman will be able to complete his work in time for its publication with the works for the present year. Should this be done, the second volume of the Bibliographia complete, a considerable portion of which is printed, will be published in 1850, with Part V of Alder and Hancock's work, and the volume of Linnæus's 'Travels in West Gothland,' translated from the Swedish by E. B. H. Lewin, Esq.

The Council, elected at the last Anniversary Meeting at Swansea, appointed J. S. Bowerbank, Esq., as Treasurer, and Dr. Johnston and Dr. Lankester as Secretaries for the past year.

Statement of Receipts and Expenditure of the Ray Society from August 1, 1848, *to September* 6, 1849.

RECEIVED.	£	s.	d.	EXPENDED.	£	s.	d.
Balance from last audit	172	16	6	Printing	223	12	3
Subscriptions from June 28, 1848, to September 4, 1849	1056	6	0	Paper	250	0	0
				Drawing, Engraving and Printing Plates	201	18	10
				Binding	190	0	0
				Translating, Editing, &c.	56	9	6
				Secretaries' expenses, rent, and distributing books	135	18	0
				Collector	20	0	0
				Advertising	8	3	0
				Local Secretaries' expenses	19	10	0
				Petty cash, Stationery, Postage, &c.	25	0	0
				Balance in hand	168	10	11
	£1229	2	6		£1229	2	6

The preceding accounts, extending from August 1, 1848, to September 6, 1849, both days inclusive, have been examined by us and compared with the vouchers, and found to be correct, leaving a balance in the Treasurer's hands of £168 10*s*. 11*d*., as per statement.

(Signed) GEORGE NEWPORT.
JAMES TENNANT.

Moved by Professor ALLMAN; seconded by J. HOGG, Esq.:

That the Report now read be adopted, and printed for circulation amongst the Members.

Moved by R. AUSTEN, Esq.; seconded by J. GRAY, Esq.:

That the thanks of this meeting be given to the President, Treasurer, Council, Secretaries, and Local Secretaries, for their services during the past year.

Moved by G. RANSOME, Esq.; seconded by Capt. IBBOTSON:

That the following gentlemen be requested to act as Members of Council for the ensuing year:

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INSTITUTED 1844.

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Squire, Lovell, esq. . . .	Falmouth
St. Andrew's University Library	
Stanger, —. esq. . .	Whitehaven
Stanger, W. M.D. . . .	Cape of Good Hope
Stark, Robert M. esq. . .	Annandale street, Edinburgh
Statham, John L. esq. . .	10, St. Peter's square, Hammersmith
Statter, William, esq. . .	Wakefield
Steel, C. W. esq. . .	Lewisham
Steenstrup, Professor . .	Copenhagen
Steuart, Sir James, Bart.	
Stevens, W. V. esq. . .	4, Upper Holland street, Kensington
Stewart, J. Vandeleur, esq. .	Rockhill, Letterkenny, Ireland
Stocks, J. C. esq. . .	Bombay Presidency, India
Stokes, W. R. esq. . . .	Shrewsbury
Stokes, Charles, esq. F.R.S. G.S. &c. .	Berkhampstead
Strickland, Hugh E. esq. M.A. F.G.S. &c. . . .	Oxford
Strickland, Arthur, esq. . .	Bridlington quay, Yorkshire

Strickland, J. H. esq.	22, North Audley street
Sweetlove, J. esq.	Liverpool, Nat. Hist. Soc.
Swineard, Frederick, esq.	Precentor's court, York
Subscription Library	Bromley house, Nottingham
Swain, P. W. esq.	Devonport
Swain, Rev. R. W.	Maidstone
Syme, John, esq.	19, Clarence street, Edinburgh
Symonds, F. esq.	Oxford
Tancred, Sir Thomas, Bart.	Shotley hill
Tate, George, esq. F.G.S.	Alnwick, Northumberland
Tatham, John, esq., jun.	Settle, Yorkshire
Taylor, Richard, esq. F.L.S. S.A. &c.	Red Lion court, Fleet street
Taylor, Henry, M.D.	Nottingham Dispensary
Taylor, —, esq.	Mr. Greenhalgh, 66, Upper Charlotte street
Teale, Joseph, esq.	Leeds
Teale, T. P. esq. *Local Sec.*	Leeds
Tennant, James, esq. F.G.S. &c.	149, Strand
Thomas, W. L. esq. *Local Sec.*	Hatfield
Thomson, A. esq.	Banchory, near Aberdeen
Thomson, Professor Allen	26, India street, Edinburgh
Thompson, Wyville, esq.	8, High street, Musselburgh
Thompson, Thomas, esq. M.A. F.R.S. &c., solicitor	Hull
Thompson, W. esq. Pres. Nat Hist. Soc. *Local Sec.*	Belfast
Thompson, George, esq.	Liverpool
Thompson, R. D. M.D. *Local Sec.*	Glasgow
Thornton, Rev. John, M.A. F.G.S.	Kimbolton
Thornwell, R. esq.	Burton-on-Trent
Thorpe, Rev. W.	Womersley, nr. Pontefract, Yorksh.
Thurgar, J. esq.	Blackheath
Thurlow, the Right Hon. Lord	Ashfield lodge, Suffolk
Tomes, Robert H. esq.	Welford, Stratford-on-Avon
Tovey, R. esq.	Ordnance Survey, Southampton
Toronto, King's College Library of	Canada
Torquay Natural History Society	
Torrie, T. J. esq. F.G.S. &c.	21, Royal circus, Edinburgh
Townsend, F. esq.	Trinity College, Cambridge
Travis, J. H. esq.	York
Trinity College	Dublin
Tripe, Dr.	Plymouth
Troughton, Nathaniel, esq.	Coventry
Tudor, Richard, esq.	Bootle, Liverpool
Tuke, W. M. esq. *Local Sec.*	York
Tuke, James H. esq.	York
Tulk, Alfred, esq.	
Turner, Dawson, esq. F.R.S. S.A. L S. &c.	Yarmouth
Turton, Geo. esq.	Sheffield
Twamley, Charles esq.	6, Queen's road, Gloucester gate, Regent's park, London
Tweedy, M. esq.	Alverton, Truro